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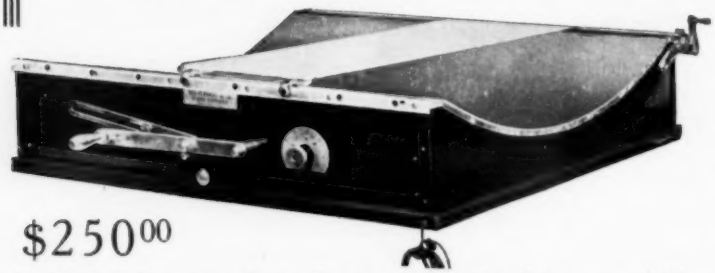

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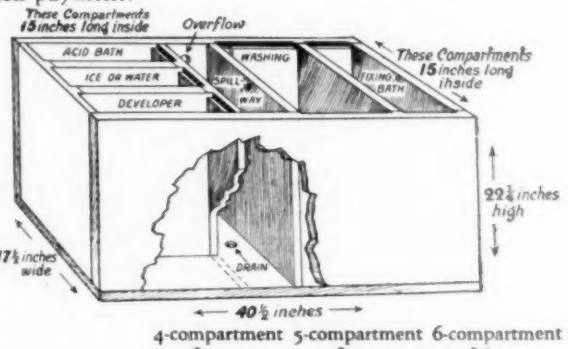

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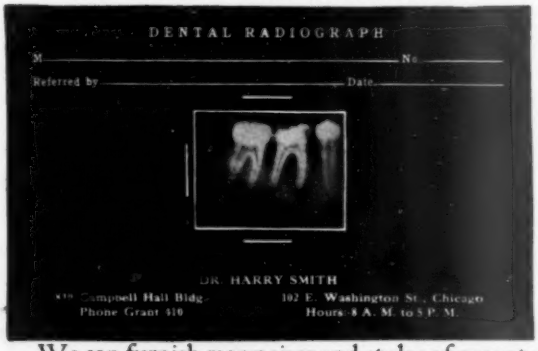

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THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

VOL. XI MAY, 1924 No. 5

SOME CONSIDERATIONS IN THE TREATMENT OF CARCINOMA OF THE ESOPHAGUS*

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Attending Surgeon, Memorial Hospital

NEW YORK CITY

A REVIEW of the more recent literature on carcinoma of the esophagus is apt to leave one with the impression that the physical agents have accomplished considerable in the relief of the disease. Unfortunately our results have not been so favorable, and for this reason we feel we should present an analysis of our experience to date.

Carcinoma of the esophagus has, up to the present, been fatal in practically 100 per cent of cases. There are obvious reasons for this. The histologic type of the growth indicates that it is extremely resistant to any form of treatment even in the most accessible locations. Situated in the esophagus, squamous carcinoma is still more formidable. Its inaccessibility and close approximation to vital organs make approach either very difficult or impossible. The esophagus is a thin-walled, flexible organ and a diagnosis of malignant disease is practically never made before the growth has extended beyond the esophageal wall. Dysphagia is almost invariably the initial symptom. This is due either to constriction of the lumen by the infiltrating annular type of growth or to occlusion by the bulky papillary type. This latter should be more amenable to treatment, but unfortunately it is less common and not usually recognized as such. A good deal of time is generally lost after this first symptom appears so that if the disease has not infiltrated widely at that period, it ordinarily has ample time to do so before the final diagnosis is reached. I am one of that minority who feels that the roentgen examination in these cases is not entirely conclusive, but a more liberal use of the barium plate as soon as difficulty in swallowing is noted would certainly turn attention in the right direction much earlier than is at present the case.

Another reason for the advanced stage of the disease before symptoms arise is suggested by Ewing. He calls attention to the anomalies of structure of the mucosa and to the canals which extend into the submucosa and even the muscular coat—the result of incomplete separation of the esophagus and trachea at an early embryonic period. It is possible and probable that the disease frequently originates in these canals and is well advanced before producing constriction or surface ulceration of the mucosa.

The various other symptoms of the disease—pain in the back or extending forward above the waist, cough, hemoptysis or vomiting of blood, recurrent laryngeal nerve pressure, supraclavicular or more distant lymph-node enlargement, are all evidences of a much wider infiltration or dissemination.

*Read at Fifth Annual Meeting of the Eastern Section, AMERICAN ROENTGEN RAY SOCIETY, Atlantic City, N. J., Jan. 24–26, 1924.

The presence of dysphagia, with or without any of these later symptoms, should certainly call for immediate roentgen examination of the esophagus. The presence of the later symptoms, even without dysphagia, should, in the absence of a more obvious cause, indicate esophageal roentgen examination. If the roentgen examination suggests an obstruction, the next step should be a direct examination with the esophagoscope. This procedure

FIG. 1. Typical carcinoma of esophagus. Roentgen-ray examination furnishes practically all necessary information here.

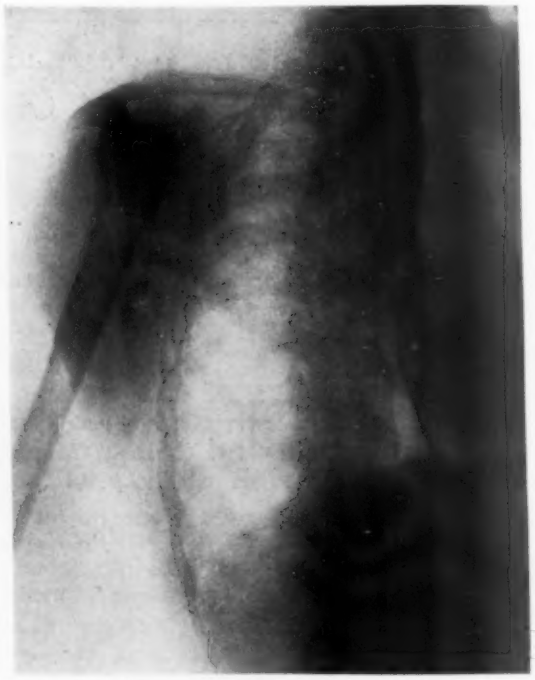

FIG. 2. Carcinoma of esophagus. Length of esophageal wall involvement not determined by roentgenogram.

can be readily carried out with a minimum of discomfort to the patient after proper cocainization of the throat, and furnishes valuable information. If the obstruction is due to carcinoma, it can readily be recognized in the gross, and a section taken to verify it. At times, but not always, a smaller instrument can be passed through the stricture to determine its lower limits and relations to the esophageal wall throughout. If the obstruction is due to pressure from without, valuable information can be obtained as to its probable origin. We have examined cases showing roentgen evidence of probable esophageal carcinoma which proved ultimately to be aneurysm of the aorta, partial calcification of the aortic arch, new growth of substernal thyroid, early mediastinal lymphosarcoma, or cardiospasm. We have also taken sections from growths at the lower end of the esophagus, quite frequently, which proved to be adenocarcinoma, thus indicating that the esophageal involvement was secondary to, and direct extension from a primary gastric carcinoma. This of course could have been settled, in most instances, by roentgen examination of the stomach as well as the esophagus, but I do not believe it is done as a routine in many clinics. It should always be done where the involvement is at the lower end of the esophagus.

I have digressed in the field of diagnosis to emphasize the importance of early roentgen examination in all cases of dysphagia and the value of the esophagoscope in both direct and differential diagnosis.

Having established the diagnosis, the question of treatment arises. This is one of the most difficult in the entire field of malignant diseases. Our problem is that of

a resistant adult type of carcinoma, nearly always in an advanced stage, inaccessible and closely related to vital organs, with a history of practically 100 per cent mortality. We must always consider treatment as palliative. This means adherence to those methods or combination of methods which give most relief with least risk and discomfort to the patient.

Before the advent of radiation therapy, the only worth-while relief was that obtained by a gastrostomy, and in many instances this relief was questionable. The various types of gastrostomy were all more or less objectionable and were usually postponed until too late to be of much service to the patient. Radiation has, in general, tended only to withhold this measure of relief until too late in a large number of cases. Many attempts were made to remove the growth surgically. All failed until Dr. Franz Torek in 1913 reported the first successful attempt at resection of the thoracic portion of the esophagus. This patient is still alive. While this was a wonderful piece of surgery, it is questionable if the single success justified the many unsuccessful attempts which were subsequently stimulated by it. The recent rapid advances in thoracic surgery are, to my mind, suggestive of very real possibilities. Not that I believe we can anticipate cure of esophageal carcinoma by surgical removal. After eliminating all of the physical factors and operative risk, the operative field is too limited, and besides, the reasonable hope for cancer cure does not lie in this direction. Dr. Lilienthal has recently shown that an esophageal carcinoma can be safely and accurately exposed surgically. While his patient unfortunately died following treatment of a recurrence after resection, it nevertheless marks a great advance and suggests the possibility of combining surgical exposure and interstitial radiation, without removal. This method has, in other parts of the body, shown some brilliant results, and it is only reasonable to believe that, in certain cases at least, it may be extended to the esophagus.

During the past seven years we have treated at the Memorial Hospital 196 cases

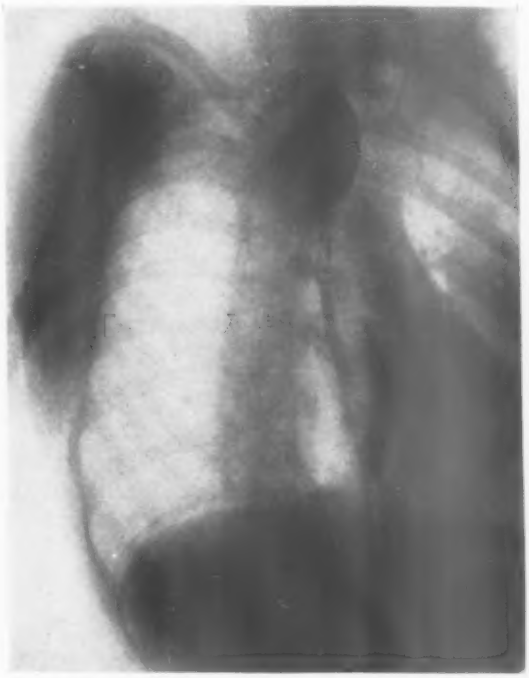

FIG. 3. Questionable stricture. Direct esophagoscopy necessary to confirm diagnosis.

FIG. 4. Questionable filling defect. Direct esophagoscopy necessary to settle diagnosis.

of esophageal carcinoma. In the beginning we were hopeful that in radium we had at least an agent which would control the disease.

Our first cases were treated during the period when radium dosage and filtration were purely empiric and experimental. Small doses seemed to control the surface ulceration, but the growth continued to extend at the periphery. Several times we felt that we were making real progress, only to find at a later date evidence of the outward extension of the disease. In other words, we were treating a canal through the central part of the tumor but exerting no appreciable influence on the bulk of it. I believe this method of small doses at intervals served about the same purpose as the periodic dilatation with bougies as practiced in some clinics. It had the added advantage of controlling surface ulceration and bleeding, to a certain extent. Our method of placing the radium within the stricture is not unlike many other plans described in the literature. We use tubes arranged end to end in rubber tubing supported by a wire, and enough tubes to cover the involved area throughout. This applicator has an enlargement on either end to prevent slipping upward or downward. We always introduce it directly through the esophagoscope for the reason that accurate approximation can always be best made by direct vision.

As soon as we attempted to control the disease by heavier intra-esophageal applications, various unfavorable symptoms arose. Evidences of a severe local reaction with consequent swelling of surrounding tissues and, at times, sloughing, were noted. This only tended to increase rather than relieve the obstruction. We also felt that the sloughing was particularly dangerous in the esophagus. It increased the factor of hemorrhage, and perforations into the bronchus or mediastinum were more frequent.

We next turned our attention to external radiation both alone and in conjunction with intra-esophageal applications. Low voltage roentgen rays did not seem to be worth while. The use of the radium pack

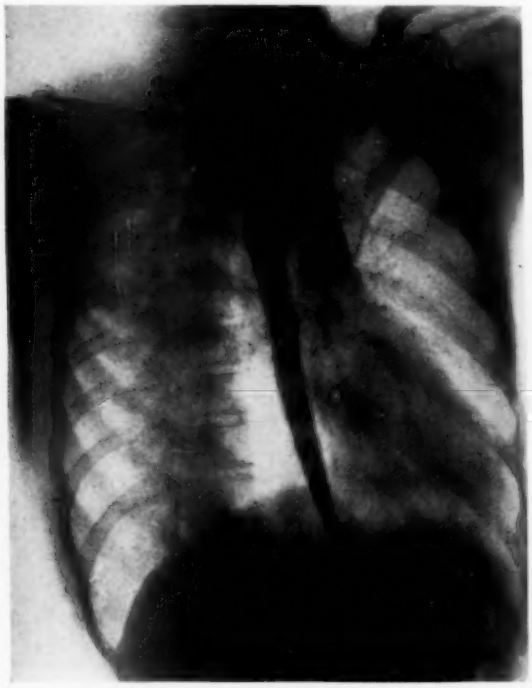

FIG. 5. Stricture of lower end of esophagus. Direct examination and biopsy necessary to determine whether growth arises in stomach or esophagus.

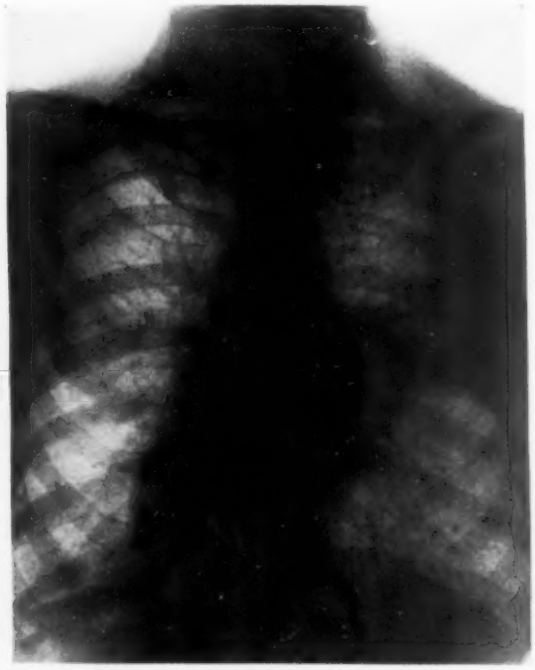

FIG. 6. Carcinoma of mid-thoracic esophagus extensively infiltrating portions of lungs.

in full doses at distances of 10 cm. and 15 cm. appeared to slow up the rate of growth and to relieve pain in certain instances. This procedure, however, was impracticable on account of the large amounts of radium required for a single case. High voltage roentgen rays have replaced this use of the pack very successfully and give results uniformly better because of the more practical economic considerations.

Throughout this period up to the high voltage roentgen ray stage, gastrostomy was employed as a last resort. In a few cases it proved beneficial, but as a rule the patient's resistance was so lowered that rebound was impossible. Our next step was to urge a gastrostomy earlier

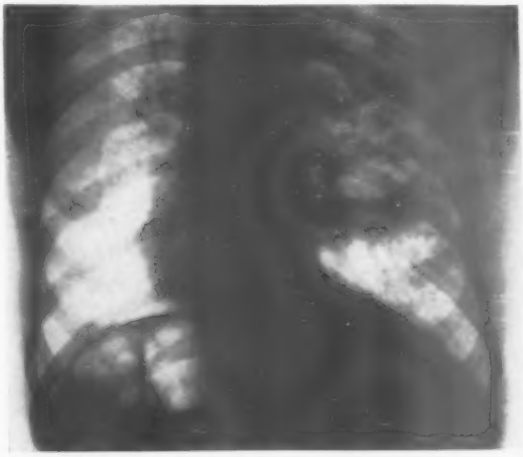

FIG. 7. Carcinoma of esophagus, ruptured, and terminating in lung abscess.

wherever the obstruction was at all marked. This was a distinct improvement and added very appreciably to the patient's comfort and length of life. We have been so impressed by the benefits of an early gastrostomy that we now urge and insist upon it in all cases at the outset, even though the obstruction be slight. The benefit is not only in the facility provided for adequate feeding, but, as Dr. Chevalier Jackson has noted, the swallowing improves after a period of rest to the esophagus. There is no question that the mechanical irritation of constant and forced efforts at swallowing increase the rate of growth, as well as the incidence of local mixed infection.

The operation should always be done at the time when the patient looks upon it as quite unnecessary. The surgical shock at this period is negligible. Most of the objections to a gastrostomy are eliminated by the technique originally described by the late Dr. H. H. Janeway. This method does away with the necessity for a continuous rubber tube, by constructing from a portion of the anterior stomach wall a tube lined by gastric mucosa. This "goose

FIG. 8. Typical case of cardiospasm.

neck" is delivered through a small opening below the lower left costal border in a manner which permits of a sphincter action by the upper abdominal muscles, and leakage of food is a negligible factor. The procedure is a simple one, easily done under local anesthesia, through a short midline incision and the patient can be gotten out of bed in three or four days. The period of confinement in bed is particularly important in the more advanced cases.

This plan of combining early gastrostomy with radiation, chiefly high voltage roentgen rays, has given by far the best results in our experience.

In our series of 196 cases, we have performed gastrostomies in 106. Unfortu-

nately many of these were done too late to be of real value. A detailed report of the entire series of cases is of no value because it is only in the more recent ones that we feel that we have developed a procedure giving a worth while chance for palliative relief. The length of life under treatment in most of the cases was short. The oldest case is now alive and enjoying reasonable comfort four years and four months after gastrostomy plus a moderate amount of radiation. Another case lived four years and three months under radiation alone and died ultimately of extension of the disease to both lungs.

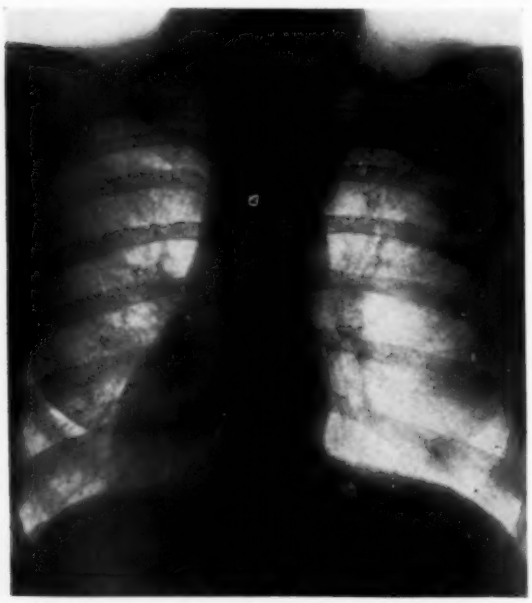

FIG. 9. Mediastinal lymphosarcoma producing symptoms very suggestive of esophageal carcinoma.

We hope that the earlier gastrostomy plus more intensive high voltage roentgen rays will in future give a longer period of palliative relief.

CONCLUSIONS

1. Carcinoma of the esophagus is a disease in which we can hope for palliative relief only.

2. An early gastrostomy offers the major portion of this relief.

3. External radiation, preferably with high voltage roentgen rays, aids in slowing up the rate of tumor growth, but so far has not controlled it.

4. Intra-esophageal application of radium, preferably in small repeated doses, is indicated to control ulceration and bleeding locally but has little influence on the actual progress of the disease.

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DISCUSSION

DR. HERENDEEN, Memorial Hospital, New York City. It seems that if anything is to be accomplished in the treatment of these cases, the main reliance must be placed upon external radiation, gastrostomy being used only as an

adjunct to the main treatment in order that the patient's nutrition may be maintained. It seems clear that the preferable form of radiation should be the high voltage method. We, as a rule, before attempting to treat these patients, roentgenoscope them with a fairly thick barium meal and mark off on the chest wall the level of the growth. Then we use, as a rule, exposures varying from 60 to 80 min. with a target skin distance of 50 cm., 4 ma., 200 kv., ½ mm. Cu. These treatments vary from three to six in number, and are given as a rule at two or three day intervals; on some occasions we have given them daily. I think that it may be wise to offer a word of caution about attempting to give the entire series in less than a week's time, and perhaps that is often too much, because of the danger of ulceration and breaking down of the tumor, subsequent leakage, perforation into a bronchus and a fatal termination as a result. Only recently have we seen a ray of hope from this method of treatment, and that largely because we have been able to maintain the nutrition of the patient or build up the patient somewhat as a result of the gastrostomy, before attempting any treatment.

Dr. Pancoast, Philadelphia. I rise to discuss this paper for two reasons, first, because I appreciate the excellent technique which has been employed by Dr. Quick in the treatment of his cases, and second, because of the stimulus recently given to me by Dr. Jackson in an effort to try to do something for a condition which has heretofore been absolutely hopeless as far as curing it is concerned. I would like to go back to the very beginning of the condition and say a word about the diagnosis. Esophageal carcinoma cannot always be diagnosed by the barium meal alone. This fact has been brought to my mind on several occasions. I had a cook in my family in whom I missed the diagnosis by the barium meal, and it was seven months before a diagnosis was made in this manner. I had her under observation practically every day in that interval. On another occasion we followed the technique we have employed more recently. Wherever we have evidence of dysphagia or, more important than that, substernal pain, because substernal pain may precede dysphagia, we always have the patient swallow a capsule, and it has never happened that there has not been something wrong in the esophagus when the capsule was obstructed. Recently we detected a carcinoma a month before it could be detected by the barium meal, and in another case a week before. The next procedure is the esophagoscope in good hands, first, to confirm the diagnosis; second, to tell the nature of the growth; and third, the extent of the growth and the size of the structure. The next procedure is a gastrostomy, before any method of treatment is employed. Dr. Jackson is firmly convinced that it is absolutely essential for many reasons.

The feeding of the patient should not be left to us, nor should it be left to the surgeon. We have found that a medical man who thoroughly understands feeding in this manner is the only one competent to take charge of the patient. He knows exactly what the man will need in the way of calories to build him up. We have attempted to have the surgeon feed the patient through the tube, and found the patient continued to go down hill, whereas if the medical man was called in the patient began to gain weight because he got the food to build him up. The patient is in better condition to have the gastrostomy made in the beginning; the mortality is much higher in the late cases than in the early ones, so we need not consider the mortality of gastrostomy cases if handled at the proper time. An additional advantage of gastrostomy is that it enables us to measure the exact extent of the growth, because Dr. Jackson and Dr. Tucker not only examine the patient from the mouth down, to get the upper limits of it, but as soon as the gastrostomy will permit, they examine the patient by a retrogastroscopy to determine the lower limits of the growth. We have been much surprised to find that it often extends throughout the entire extent of the esophagus, from the upper constriction down to the stomach; in fact you may find multiple lesions that need treatment. The first case called to our attention was reported by Dr. Smiles, in which a carcinoma of the upper part of the esophagus was treated over a period of two or three years, and then later on they found a lesion at the lower end of the esophagus, probably metastatic from the upper lesion. It is absolutely necessary to get the entire extent of the lesion before you put in your radium applicator, and also to get the number of lesions which may be present. We have been surprised in some instances by following this technique to find exactly what Dr. Quick shows, that we were not dealing with an esophageal carcinoma at all, but with an upward extension from a carcinoma of the stomach. The biopsy may bring this to our mind by showing a different type of carcinoma from that usually found in the esophagus.

Dr. Manges, Philadelphia. I would like to say a word about the method of examining these esophagus cases. You will recall that sometime ago I advocated the prone position for demonstrating lesions of the esophagus. It is true that a lesion of the esophagus that

narrows the lumen sufficiently to retain a capsule, will show that there is a narrowing at that point; but it tells nothing about the condition of the esophagus below that. If you have the patient in the upright posture and the stricture is fairly narrow, the barium trickles through slowly and immediately goes in a narrow stream into the stomach, and you get no idea of the condition of the esophagus below the level of the stricture; neither would you with the capsule, but if you have the patient in the right oblique prone posture and the lower end of the esophagus turned up a little to the left, it becomes the highest point. The patient then drinking through a rubber tube, fills the upper portion and by means of the swallowing effect plus the peristalsis of the esophagus, forces the barium mixture past the stricture or through the stricture area and it stays in the lower portion of the esophagus long enough for you to get an idea as to its lumen. I first got this from a study of the foreign body cases and especially the constricted esophagus following the drinking of some irritating substance such as lye. There may be strictures in these cases at different levels, and where you have the stimulus of operation to cure the patient, you are apt to go to much greater lengths to study it, knowing that they can dilate those strictures. It was a stimulation to me to go ahead and find out what the condition of the entire esophagus was, and we have on more than one occasion demonstrated very definite constrictions at widely separated points, so that if you will examine those cases of carcinoma of the esophagus and especially those below the level of the suprasternal notch in the right oblique prone posture, you will get along without the necessity of using capsules and get a very definite idea as to the extent of the growth.

Dr. Holmes, Boston. I would like to say a word first in regard to the diagnosis. Our trouble has not been in differentiating these lesions of the esophagus from tumors outside or from cardiospasm, but it has been in missing the very early cases. I think that is where the direct esophageal examination is going to be of the greatest aid to us, before any true stricture has taken place and while roentgenologic evidence is still absent. In most of the cardiospasms, a drink of some hot liquid may relax the cardiospasm. I have seen that happen a number of times; there is a good reason why it should tend to relax under heat. Then there is the question of lung metastases in these cases. The case Dr. Quick showed no doubt was metastasis, but I have seen very similar cases due to inhalation of ammonia. These cases have difficulty in swallowing, so we must not be discouraged entirely if we find something in the lung that looks like a metastasis. Then on the question of treatment, we have been through practically the same thing Dr. Quick has described and arrived at practically the same conclusions. There was one thing in the treatment of cancer of the esophagus which should urge us to try hard for a cure by radiation, and that is, it is a tumor that does not metastasize early; and secondly, it is practically never cured by surgery; so that here we have a tumor which ought to be discovered fairly early, though it is not, and which does not metastasize early and is no more resistant to radiation than some forms of skin cancer which are cured by radiation. We have not resorted to gastrostomy as early as the gentlemen here have advised, and I think we are justified in some cases. We have a case under treatment now of a patient who was able to eat any sort of food, who, when he came to the clinic, was unable to swallow anything except liquid; I wonder if a case such as that with the cauliflower-like growth out into the esophagus which could be reduced with a small amount of radium seeds and cross-fire radiation, might not be handled without a gastrostomy, and if cases of lymphoma pressing on the esophagus, which would respond readily to roentgen treatment could be handled without gastrotomy. Certainly a patient when he first has a gastrotomy done, has more difficulty in handling his food and keeping up nutrition than if he can eat in a normal manner.

Dr. Quick. In reference to using the bare tubes directly in the growth, I think it is a hazardous procedure. We tried it, but with disastrous results. The esophagus is a thin-walled organ, surrounded by many important structures, and I think the danger considerable. Even if we were to get what ultimately would be a satisfactory regression of the local area, there would be enough swelling incident to the radiation to interfere seriously with nutrition.

I should have liked to mention several things relative to diagnosis, but I felt that that did not come quite within the scope of the paper. I am grateful to the gentlemen for discussing that side of it. There are two points which I wanted to make: first the use of the esophagoscope in diagnosis; second, early gastrostomy to provide for the nutrition of the patient while we were doing what we could by way of palliative radiation.

Dr. Dunham, Cincinnati, O. I would like very much to know if there have been any cures in any of those cases? Has anybody had a case get well?

Dr. Quick. The only cure that I know of is the surgical case reported by Dr. Franz

Torek, and just before coming down the other day I called him up. He said the patient was still alive. I think we all get spasms of enthusiasm once in a while. One case I referred to we had watched carefully at intervals, making regular examinations by the direct method up to nearly four years, the lesion was healing, it looked very well; then the patient came in coughing a little one day, which answered the whole question—we had very successfully treated a hole through the growth all this while; meanwhile it was extending little by little; the roentgen findings at that time were verified by an autopsy four months later.

THE DIAGNOSIS OF PRIMARY INTRATHORACIC NEOPLASMS*

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THE diagnosis of primary intrathoracic neoplasm is a problem of peculiar interest to the roentgenologist. In the vast majority of cases, the lesion is elusive to the ordinary methods of physical examination and often no suspicion of its presence is entertained until evidence of some unusual condition is disclosed by the roentgenogram. The lesion is not rare but is infrequent enough to test one's diagnostic alertness. The roentgenograms present features which occasionally are almost pathognomonic, but more frequently challenge the keenness of observation and deductive faculties of the roentgenologist. Furthermore, the possibility that intensive treatment with short wave-length radiation in the malignant cases may prove of more than temporary benefit, places on us a very definite responsibility to do our utmost toward the early detection of these lesions, so that if the lesion is malignant, treatment can be started at the earliest possible moment when the area of involvement is limited and before metastasis has taken place. On the other hand, if the lesion is benign, an unfavorable prognosis should be avoided and the patient not subjected to radical treatment, either by surgery or the roentgen ray, (which, when applied to the lungs especially, cannot be regarded as other than a radical procedure). The roentgenologist who gives such a treatment must bear his share of the responsibility in so far as the roentgen ray can be of value in the differential diagnosis.

This paper will be devoted chiefly to a presentation of 6 consecutive cases of primary malignant tumors of the lung correctly diagnosed before death and proven by autopsy, on which the authors have collaborated in the Cleveland City Hospital during the past eighteen months. The diagnosis in 1 case was primary chondrosarcoma of the lung. The remainder are cases of primary bronchial or lung carcinoma, and our discussion will be primarily of this type of tumor. In 2 of the cases, the roentgenograms furnished the data upon which the diagnoses were based.

To emphasize the need of routine roentgen-ray examinations of the chest, we are reporting, in addition to these 6 cases, 2 others (from the records of Drs. Hill and Thomas) in which the physical signs were negative at the time the diagnoses were made from the roentgenograms. One was an endothelioma, probably of mediastinal origin, which in some respects resembled a primary lung tumor. The other was a benign tumor, which had been diagnosed as a xanthoma. It is of special interest because primary benign tumors are extremely rare and the coincidence of roentgenographic and pathological findings even more infrequent.

A survey of the literature would not lead the casual reader to place much dependence on roentgenography as an aid in the diagnosis of lung tumors. A careful analysis, however, of those articles which report in detail the clinical data, pathological reports and especially the roentgenographic findings of proven cases of primary intrathoracic neoplasm, shows so definitely the value of roentgenography in this connec-

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tion that we cannot ignore statements, which have been passed down as a sort of legacy by succeeding authors, to the effect that "in the diagnosis of lung tumors, the roentgenograms have been either of negative value or at times even misleading."

To pass by such statements without criticism would be the grossest neglect, in view of our firm conviction that whatever improvement has been made in the diagnosis of diseases of the lung in the past twenty-five years or more is due in most part to the science of roentgenology. We know, and it is the primary object of this paper to show, that failure to resort early and routinely to careful roentgen-ray examination of the chest will result in the failure to detect and diagnose a large percentage of intrathoracic neoplasms.

Without special search, one of us has found (in the files of Drs. Hill and Thomas) records of a dozen cases of malignancy of the lungs, several of them primary, diagnosed directly because of the roentgen-ray findings and subsequently proven by autopsy or biopsy or adequately verified by the subsequent clinical history. We cannot recall one case where a lung tumor was found at autopsy in a patient whose roentgenogram was negative. We have found only two such cases reported in the literature.

Fishberg and Steinbach claim accurate diagnoses in 32 out of 33 cases of cancer of the lung and say it is their conviction that the cases were diagnosed during the life of the patient, because they "relied mainly on purely clinical methods, on the history, symptomatology, course and physical signs, while other diagnostic and laboratory methods such as cytology of excretions and exudates and radiography were invariably considered of merely confirmatory importance." This implies that practically all cases of lung tumor can be diagnosed without the aid of the roentgenogram. We admit that the percentage of diagnostic accuracy could not have been much higher, even if their list of diagnostic procedures of merely confirmatory importance had included the autopsy itself. But our experience and a review of the literature convinces us that roentgenography must have directly or indirectly played a greater rôle in these diagnoses than the authors realize. With its aid, and with proper cooperation between clinician and roentgenologist in the interpretation of data obtained from the "history, symptomatology, course, physical signs," laboratory findings and especially the roentgenograms, we agree that most cases of cancer of the lung can and should be correctly diagnosed. Without it, even with the increased accuracy in the interpretation of physical signs that has resulted from the use of the roentgen ray, many cases, not only of lung tumor, but of all kinds of lung disease, will be incorrectly diagnosed. A comparison of physical diagnoses with the autopsy findings in any large clinic proves this. In some cases, especially in early cases of lung tumor, the physical signs are negative. In others, the only physical signs are those of the complications, most frequently pleural effusion. In the absence of any further data, the examination would end there, and the correct diagnosis of the primary lesion, the lung tumor, would not be made.

The rarity of such diagnoses before the advent of the roentgen ray indicates the truth of the above statements. The comparative frequency since cannot be accounted for by any slight increase in the incidence of the disease, nor do we believe it can be entirely explained by any improvement in the art of physical examination or correlation of the physical findings with the symptoms and clinical history.

Most authors have agreed that lung tumors are rarely diagnosed clinically. In a series of 90 cases of bronchial carcinoma collected by Weller in 1913, only 10 were correctly diagnosed. Barron in 1922 reported a series of 13 cases, but only 3 out of the 13 were finally given correct clinical diagnoses. Many other articles might be analyzed and quoted, but these few are sufficient to show that even at the present time, for one reason or another, most cases of lung tumor are not recognized until post mortem.

This, at first glance, would appear to be a sad commentary on our methods of diagnosis, in view of the fact that most cases of lung tumor present symptoms referable to the chest, and especially in

view of the fact that physical conditions could hardly be more ideal than in the thorax for purposes of physical examination and roentgenography. We are convinced, however, that the fault lies, not so much in the inadequacy of available diagnostic methods as in a failure to use them and to properly evaluate the data obtained when all the methods are used. In Barron's 13 cases, for example, apparently only 6 were roentgenographed. The roentgen-ray findings as reported were almost diagnostic in 4 and were very suggestive in the other 2, but only 3 of the entire 13 cases were finally given correct clinical diagnoses. It is evident that too little reliance was placed upon the roentgenograms. An analysis of the autopsy findings in the 7 cases not roentgenographed indicates that roentgenograms should have been helpful in all, and might have been pathognomonic in some. In none could they have been negative.

Next in importance to making a roentgenographic study of the chest as much a part of the routine examination of every patient as the usual physical examination, is the method of utilizing the data thus obtained. The roentgenogram records variations in density according to fixed physical laws. It may be assumed that every abnormal shadow means a corresponding abnormality in the patient, and conversely that every gross pathological variation in density should produce a corresponding variation of shadow on the roentgenogram. This does not mean that the outline of a lung tumor can be distinguished through a pleural effusion or that one can differentiate the shadow of a tumor from the surrounding lung that is drowned in an exudate consequent to the occlusion of a bronchus. Some lung tumors may be too small or may not produce enough variation in lung density to be detectable on the roentgenogram. In one rare instance a small tumor in the upper right bronchus disappeared into the shadow of the spine when the upper lobe collapsed. But these obvious limitations do not alter the fact that the roentgenogram is essentially accurate; in fact, outside of actual section, the most accurate method we have of detecting any gross pathological change in the lungs. As such, it should serve as a basis for further investigation rather than being used as a means of confirming or disproving a diagnosis arrived at by less accurate methods. This practice is in no small part to blame for the unfavorable appraisal of the roentgenogram entertained by many internists. A hasty glance at an "x-ray picture" will often "confirm" an incorrect physical diagnosis. A careful study of roentgen-ray shadows should never prove misleading. We have often found that the presence of shadows that gave the clue to the correct diagnosis, was not detected or considered of any significance by those who had already formed a diagnostic opinion from other methods.

A knowledge of the gross pathological characteristics of primary lung carcinoma is fundamental, not only in the interpretation of the physical and roentgen findings but also in the synthesis of the information derived from these two methods. The following brief summary of them given by Moise serves unusually well to bring out the features of interest in the interpretation of roentgenograms. "The gross anatomic appearance of lung tumors is very variable and there are no well-defined gross types. A nodular form, an infiltrating form, and a miliary carcinosis have been described, and these descriptive terms are frequently used in classification, although they are obviously applicable rather to stages in the growth of a tumor than to distinct types of tumor. The nodular form includes rare cases of a single nodule or a few small nodules in the pulmonary parenchyma, or localized papillary tumors arising in the walls of tuberculous or bronchiectatic cavities and are only discovered incidentally at necropsy. The infiltrating form is the usual finding, as the majority of cases are seen in an advanced stage when there is extensive invasion or infiltration of the lung. In these tumors the most significant gross finding is that the tumor is confined to, or is much more extensive in one lung, while secondary tumors are frequently distributed widely throughout both lungs. In advanced stages of the primary tumors, the distribution of the cancerous invasion within the lung is

quite uniform, the bronchi and blood vessels are encircled by bands of tumor, which become more and more conspicuous as the hilum is approached. These peribronchial tumor masses may compress the larger bronchi with resulting total or partial occlusion leading to atelectasis and bronchiectasis. A large mass of carcinomatous tracheobronchial lymph nodes is frequently found filling the angle between the main bronchi. The hilic nodes on the opposite side are not infrequently involved, but the opposite lung itself is relatively free from tumor nodules. The cases described as miliary carcinosis are said to resemble miliary tuberculosis, except that the nodules are somewhat larger, more translucent and whiter in color, and are situated only along the course of the lymphatic channels. This finding is apparently indicative of an early widespread lymphatic invasion of the lung."

Most pathologists have considered that there are three types of carcinoma of the lung, one arising from the lining epithelium of the bronchus, another from the mucous glands and the third from the alveolar epithelium. Recently the last class has been considered very rare, some question its occurrence at all. Accurate conclusions regarding the point of origin may be impossible because different sections of the same tumor may show characteristics of all three types. It is generally agreed that most are of bronchial origin, usually from the main branches, although some apparently originate from the smaller bronchioles.

Ewing indicates that a bronchial carcinoma that arises from the lining epithelium is rarely a large diffuse tumor of the lung; it usually arises at or below the bifurcation of the trachea and extends along the walls of the bronchi; the bronchi may be occluded with papillary projections resulting in bronchiectasis; these tumors are apt to break down with the development of cavities filled with mucopurulent material; they may extend into the mediastinum, the pleura and the chest wall; pleural effusions in this type are frequent. He further states that carcinomas arising from the mucous glands are limited chiefly to the walls of the bronchi; that they arise from the same region as the former type; there may be considerable infiltration of the parenchyma; that as a rule the bronchial lining is intact, but may collapse into folds, the characteristic tendency being to stenosis of the bronchi rather than dilatation. In this type, on account of the compression of the bronchi, we have sclerosis and atelectasis and contraction of the lung. The pleura may become thickened and there is usually invasion of the hilar lymph nodes. The diffuse type may resemble pathologically an atypical, acute pneumonic process. Cavities may develop in areas of necrosis. The pleura is usually involved. Local and general metastases are frequent.

The arteries, veins, air passages and lymphatic channels are the obvious routes of extension and metastasis. The lymphatic distribution is of especial interest in explanation of the occasional triangular shaped areas of involvement in the parenchyma, and the limitation of the area of density to the interlobar line, so frequently sharply outlined in upper lobe tumors.

There are two sets of lymphatic channels, one following the branchings of the bronchial tree, the other distributed through the pulmonary pleura. Normally, both the pleural and the pulmonary channels drain in opposite directions from the surface of the lung toward the hilar lymph nodes. The only peripheral anastomoses between these two sets are the lymphatic channels in the interlobular septa. These channels contain valves which prevent the flow of lymph from the pleura to the deep lymphatics of the lung, but allow drainage from the lung to the pleura if the normal drainage along the bronchial tree is obstructed. The lymphatics accompanying the bronchial tree anastomose freely, especially about the points of division of the bronchi and bronchioles.

Metastases occur in a large proportion of cases, the more important sites in order of frequency being the regional lymph nodes, liver, pleura, kidney, lungs, brain and bones.

In Hodgkin's disease, lymphosarcoma and other tumors arising from the mediastinal or hilar nodes, we occasionally find infiltration of the surrounding lung tissue, which may simulate the appearance

of a bronchial carcinoma. With the exception of lymphosarcomata involving the mediastinum, primary sarcomata in the chest are extremely rare.

Benign intrathoracic tumors are even more infrequent.

Most cases of pulmonary cancer present symptoms referable to the chest, though in a few cases recorded, the only symptoms were those resulting from metastases, frequently in the brain. In a couple of cases reported, a fatal hemoptysis was the only symptom. Cough and dyspnea occur in almost every case. The cough may be dry or may be accompanied by expectoration. Blood tinged, or raspberry jelly-like sputum is very suggestive. Pain occurs in the majority. It may be referred to the shoulder or arm on the affected side and occasionally to the abdomen. It is rather characteristic in its early occurrence, its gradual onset, and its persistence, and it is not relieved by the presence of a pleural effusion. It may at first be only a feeling of oppression. Dyspnea occurs in practically every case. It is usually progressive.

Weakness is often noted early and appears to be out of proportion to other physical signs. Loss of weight is usually progressive, but may not be marked until the final stage. As in malignancy elsewhere, the patient may have periods during which the weight increases. Fever may be present because of the frequent inflammatory complications.

When any patient past middle life gives a history of progressive dyspnea or persistent pain in the region of the chest, the possibility of lung tumor should be considered, especially in the absence of cardiovascular disease, and the patient should be submitted to careful physical and roentgen-ray examinations. For the purpose of elimination, the roentgen ray is of prime importance inasmuch as it would be very rare to have negative roentgen findings in any case in which the tumor had progressed far enough to cause symptoms. The physical examination may show changes in auscultatory sounds, but would probably be negative from the standpoint of percussion, until later stages. A layer of unimpaired lung a few centimeters thick is usually sufficient to disguise the presence of a tumor to palpatory or indirect percussion.

The physical signs vary according to the size and location of the growth and the amount of involvement of the air passages with the accompanying secondary changes. The interpretation of the physical signs is facilitated by the knowledge of the presence, the location and the extent of the involvement as shown by the roentgen-ray examination. Percussion may vary from normal over small tumors to flatness over airless lung or dullness or flatness over those that have extended to the chest wall. If the tumor is central, whatever change there is in the percussion note will be due to change in the air content of the overlying lung. Sometimes the variation in the note from that obtained over the surrounding uninvolved region is not enough to be detectable. Tumors several centimeters in diameter are occasionally discovered by routine roentgen-ray examination in cases where such a lesion cannot be suspected from the physical signs elicited either before or after the presence of the tumor has been demonstrated.

The breath sounds may be diminished or absent. A partial occlusion of a bronchus may give rise to a peculiar amphoric breath sound called cornage, which sign is very suggestive of bronchial carcinoma.

About 50 per cent of cases have pleural effusion with associated signs of absence of breath sounds and flat percussion note, that is, the same as might be caused by the tumor itself.

Enlargement of the supraclavicular or axillary lymph glands is suspicious especially in conjunction with evidence of disease in the chest. Nodules may be found on the sternum or ribs. Sections of these glands or nodules may decide the diagnosis.

Hemorrhagic effusion should at once suggest the possibility of malignancy. Occasionally cells may be present in the aspirated fluid or in fragments of the tumor caught in the needle which will disclose the identity of the growth. In one of the cases we are reporting, Dr. Howard Karsner was able thus to determine the type of tumor.

Edema of the face and neck, or distention of the superficial veins of the chest

may result from involvement of the mediastinum, because of pressure on the venae cavae.

The problem of differential diagnosis may be diagrammed as follows:

Inflammatory processes vs. Neoplasms	Benign		1. Mediastinal 2. Pulmonary 3. Pleural	
	v.s.			
	Malignant	Primary	vs.	1. Mediastinal 2. Pulmonary 3. Pleural
		Secondary		Ditto

The differential diagnosis indicated on this diagram can be made in almost every case. The roentgen shadows may be as varied as all the pathological combinations can make them, but most cases of primary lung tumor present pictures that are quite unlike the more usual inflammatory processes with which they are so often confused clinically. The most frequent incorrect clinical diagnosis is pulmonary tuberculosis. This error would occur in the interpretation of the roentgenograms only in those cases where a miliary carcinosis might be confused with miliary tuberculosis, or massive lobar cancer with caseous pneumonia. The respective rarity of primary miliary carcinosis and massive lobar tuberculosis would make these errors uncommon. In such cases, or in any other, where the roentgenogram simulates, an infectious process, one would hardly expect a coincident similarity in the physical signs and clinical history. The differentiation between benign and malignant neoplasms may sometimes be indicated by the clinical progress, and a study of the method of growth, by repeated roentgen examinations of the periphery of the tumor from different angles. The law of probabilities favors malignancy. Rapid growth, an indistinct border, radiating projections from the tumor mass, multiple nodules, evidence of metastases to ribs or vertebrae and pleural effusion would indicate a diagnosis of malignancy. Lack of growth, and the maintenance of a sharply defined border would be roentgen evidence in favor of nonmalignancy. Erosion of the ribs or vertebrae by pressure in benign tumors would be sharply limited to the contour of the tumor shadow itself.

The location and distribution of the mass might indicate the point of origin. Massive density of the posterior mediastinum extending bilaterally with comparatively clear lung fields would favor mediastinal origin, especially if the lateral borders are smooth and clear-cut. Unilateral hilar involvement even with mediastinal density is more suggestive of primary bronchial carcinoma.

The differential diagnosis of metastatic processes is not usually a difficult problem. The roentgen-ray findings are frequently pathognomonic as in certain cases of metastatic sarcoma, or they are suggestive because of the distribution throughout both lungs. Even in the cases that simulate primary carcinoma, the history or the accompanying signs of the primary lesion usually make the differentiation.

Before discussing in particular the roentgen-ray findings in cases of primary carcinomata, we wish to emphasize the fact that stereoscopic views are of greatest value and should always be made. Increasing the tube-plate distance and making both anteroposterior and posteroanterior views will occasionally bring out small nodules that may be indistinct and diffused by a too divergent beam of rays. Lateral and oblique views often are of great value.

In diffuse carcinoma of the upper lobe, which most authors agree is most frequently involved, the lower border of the density is sharply outlined, the upper border fades out into the apex, which is usually comparatively clear.

Some cases of hilar carcinoma show a mass of density about the hilum with radiations extending outward along the bronchial branches but thinning out, sometimes abruptly, not far from the hilum. The lung parenchyma may be quite clear except for possibly a couple of nodules. From one of these peripheral nodules, there may be a triangular shaped area of density extending outward to the lateral chest wall, the nodule forming the apex of the triangle.

Other cases show a large massive shadow about the hilum. The outer border may be clear-cut and contrast sharply in density with the surrounding lung. The border is not, however, as smooth as in some of the

mediastinal growths where the lung is pushed ahead of the growth.

Occlusion of the bronchial lumen in hilar carcinoma would produce atelectasis of the corresponding part of the lung and this area might resemble a pneumonic process, or there might be merely a veiling of the lobe affected.

Paracentesis should be performed in all cases in which there is a pleural effusion and then the case should be immediately roentgenographed especially if the fluid is sanguineous. The return of the fluid in malignant cases is usually rapid and within twenty-four hours may be the same in amount as before withdrawal. This is in itself suggestive of malignancy. The withdrawal of even a small amount of fluid may reveal nodules otherwise hidden.

We have not derived any special aid from the production of an artificial pneumothorax in the few cases where we have tried this procedure. In one case, not included in this series, the tumor showed up more clearly before the lung collapsed around it.

In cases where there appears to be a large amount of effusion present without displacement of the heart to the opposite side, one must consider the possibility of lung tumor. The heart is frequently found displaced to the affected side even in cases where almost the whole side is opaque. Later, when the tumor itself increases sufficiently in size, the heart may be displaced to the opposite side as in pleural effusion without adhesions. The conditions that would displace the heart to the affected side would be apt to result also in asymmetry of the chest, the affected side not expanding to the proper degree. The excursion of the diaphragm on that side would also be limited.

These findings, in the absence of symptoms of acute obstruction, and decreased transparency of one or more lobes, indicating collapse of the lung, should suggest the possibility of occlusion of an air passage by a growth of some kind. A bronchoscopic examination would be of value and material might be secured for histological study.

When small circular nodules of moderate density, larger than ordinary tubercles, and surrounded by fairly clear lung, are found, one must think of malignancy, especially if a couple of such nodules are found along the same branch, and the density of this branch is accentuated, as would result from a peribronchial lymph infiltration. The size, especially variation in size, and distribution, usually help in the differential diagnosis from tuberculous and other lesions. The usual characteristic mottled cloudiness of the parenchyma found in the ordinary case of pulmonary tuberculosis is of itself pathognomonic. It is furthermore often bilateral; primary lung carcinoma rarely so until the later stages. Then, the side primarily involved would be apt to show massive dense areas due either to the tumor itself or the secondary changes due to occlusion of the bronchi.

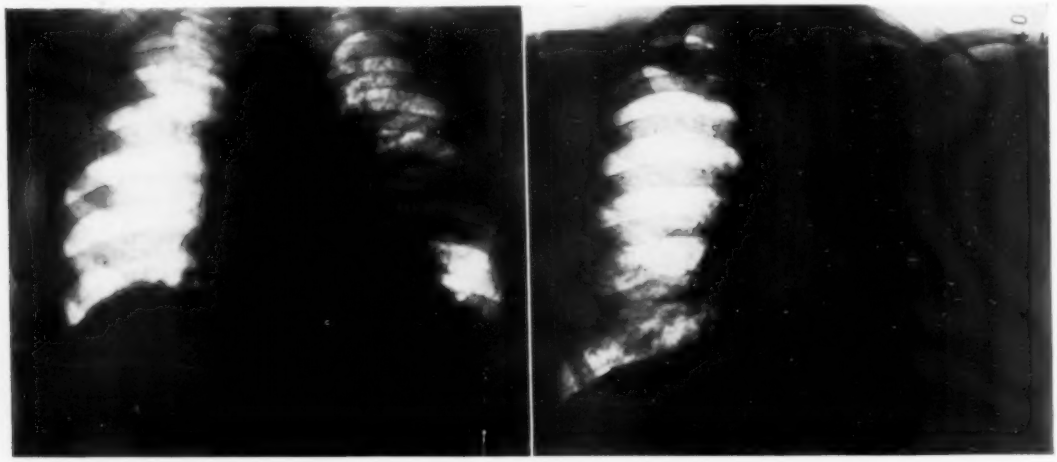
We have seen very marked hilar density with infiltration along the larger bronchi that clinically appeared to be due to syphilis. This type might be mistaken for malignancy. A comparison of roentgenographic findings and symptoms after a period of anti-luetic treatment would be very helpful in the final diagnosis. We believe this type of luetic involvement is extremely rare.

Hodgkin's disease and lymphosarcoma may simulate a hilar carcinoma very closely. Blood study, the involvement of superficial lymph nodes, and the rapid therapeutic reaction to mild roentgen radiation would help to establish the diagnosis.

In conclusion, we are reporting the history, symptoms, physical findings, roentgenograms and pathological reports of 8 cases of primary intrathoracic neoplasms, all of which were correctly diagnosed during life. An analysis of these will indicate the data upon which the diagnoses were based.

We wish also to emphasize that failure to resort early and routinely to careful roentgen-ray examinations of the chest will result in the failure to detect and diagnose a large percentage of intrathoracic neoplasms. In the earlier stages, before the complications of pleural effusion, compressed or fluid-filled lung, have taken place, the roentgenograms may be the

more characteristic. In the later stages, the roentgenograms may still show pathognomonic evidences of lung tumor, or such an unusual combination of findings that suspicion of the presence of a lung tumor or other rare lesion is aroused and further investigation resorted to. Most cases of lung tumor with symptoms referable to the chest, can be correctly diagnosed if there is careful synthesis of the physical and roentgenographic findings together with a careful analysis of the clinical history. Even with absolutely negative physical findings, one cannot eliminate the diagnosis of an intrathoracic neoplasm with any degree of accuracy except with the supporting evidence of a negative roentgenographic examination. On the other hand, the routine roentgen-ray examination, especially in cases without symptoms referable to the chest, is the most accurate method we have of detecting the presence and the location and distribution of a consolidating process in the chest, the picture in some cases being characteristic enough to indicate the diagnosis. Roentgenograms made to study the progress of an obscure case furnish a permanent, more accurate, and more tangible basis for comparison than the recorded observations of changes in the percussion note and breath sounds. The interval examinations are, therefore, most valuable in the making of a differential diagnosis.



FIGS. 1 and 2. Case I.

CASE I. Male, landscape gardener, aged fifty-five.

Complaint. Slight shortness of breath and feeling of tightness under the sternum.

Physical Examination. Rales in both bases. Otherwise negative.

Roentgen examination, Jan. 6, 1923. (Fig 1). We are indebted to Dr. R. J. May, St. Luke's Hospital for the use of this roentgenogram. This plate shows a mass of uniform density about one and one-half inches in diameter in the lower portion of the upper left lobe, and uniform veiling of the upper two-thirds. The lower third is about as clear as the corresponding region on the right side. There is accentuation of the peribronchial shadows throughout the upper left lobe, with small nodular shadows along the branches. Increased density about left hilum. The right side is comparatively clear.

Admitted to Cleveland City Hospital June 4, 1923; discharged June 30, 1923.

Complaint. Shortness of breath which began about six months ago with associated cough. To prevent coughing he must sleep lying on the left side. Patient has some dull pain in the epigastric region. Exercise causes palpitation of the heart.

Physical Examination. Well-developed and well-nourished male of stocky build. Respiration is almost wholly right-sided, with respiratory retraction of the entire left costal margin. Percussion note uniformly flat over entire left side and fremitus

considerably reduced. Heart displaced to the right. Breath sounds are diminished in intensity but are high pitched and tubular in character over the left chest.

Two hundred fifty c.c. of turbid fluid containing fine flocculi were aspirated from left chest; sp. gr. 1020; clot formed on standing, and it solidified on boiling. Microscopic examination showed clumps of cells larger than white blood cells, and some resembling giant cells. Culture of fluid showed no growth. A second tap yielded no fluid.

Temp., normal; resp., 20; vital capacity, 1600 c.c.; B.P. right arm, 122; B.P. left arm, 144; white blood cells, 10,600; hemoglobin, 80 per cent d.; urine, neg.; blood Wass., neg.; roentgen examination June 5, 1923 (Fig. 2). Left side of chest entirely opaque, except for slight thinning out of density toward apex. Heart retracted to affected side.

Second admission Dec. 23, 1923. Died Dec. 31, 1923. Patient never lost weight until three months ago. Used to weigh 160 lbs.; now weighs 105 lbs. Since last admission has had much pain in left shoulder but no limitation of motion in the joint. Has had considerable epigastric distress and condition has gradually grown worse. Physical findings in chest practically same as at last admission. Patient orthopneic and cyanotic.

Roentgen examination Dec. 29, 1923. Heart displaced to the right at least an inch beyond the position shown in the previous examination. Marked mottling along the bronchi in the lower half of the right lung, especially toward the base, which has developed since the previous examination. Asymmetry of chest. Left side contracted.

Autopsy. 450 c.c. chocolate-colored fluid encapsulated in pleura over anterior upper left chest. Pleural cavity obliterated. Diffuse carcinoma involving both lobes on left. Miliary carcinomatosis of middle and lower lobes on right side.

Case II. Male; laborer, aged sixty-four. Admitted to Cleveland City Hospital May 12, 1922; died June 6, 1922.

Complaint. Pain in the left side of face and forehead, of three weeks' duration.

Physical Examination. A well-developed and well-nourished Italian male. The left eye deviates to the nasal side and there is marked ptosis of the lid. No nystagmus. There is a hard firm nodule the size of a walnut attached to the upper end of the manubrium which was first noticed by patient four weeks ago. The left costal margin moves less than the right. Dullness at the left base with breath sounds distant or absent. Vocal fremitus impaired. One hundred c.c. of green turbid fluid aspirated from the chest, May 24, 1922. Biopsy of nodule from manubrium showed carcinoma.

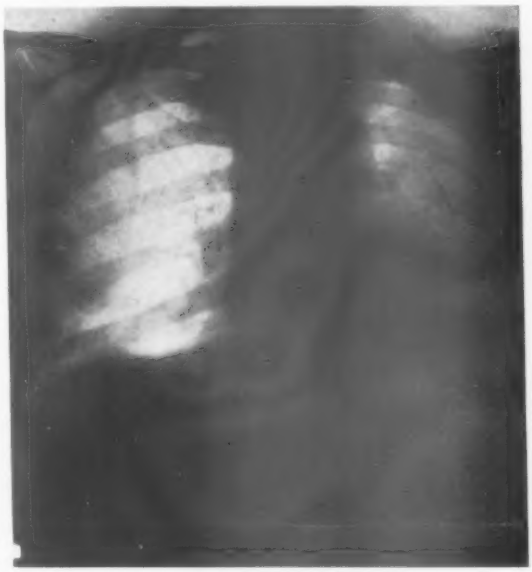


Fig. 3. Case II.

Blood and spinal fluid, Wass. neg; temp., 36.5°C. to 37.5°C. Terminal rise to 40°C. Pulse 70 to 100., resp. 18 to 22.

Roentgen examination (Fig. 3). Chest asymmetrical. Left side contracted. Heart retracted to left side. Dense shadow extending downward and outward from left hilum toward chest wall. At the outer portion, the shadow suggests a separate nodule. Just below this, there is another nodule about one-half inch in diameter. Upper left lobe filled with small nodular shadows scattered throughout the lower portion especially. Right side comparatively clear; complete absorption of the left second rib inside scapular line.

Autopsy. Hydropleura left side, 250 c.c. Lower left lobe airless and completely

filled with tumor tissue. Large nodules in upper left lobe. A grayish mass at left hilum narrowing the lumen of bronchus of left upper lobe. Non-keratinizing squamous epithelioma primary in lung. Metastases to liver, both adrenals, sternum, clavicle and ribs.

CASE III. Male; engineer, aged seventy-four. Entered Tuberculosis Sanatorium of Cleveland City Hospital, April 30, 1923; died June 15, 1923.

FIG. 4. Case III.

Complaint. Cough, loss of weight, weakness, pain in chest. Patient was well until nine months ago when he started to cough and lose weight. Has lost 50 lbs. since onset and has not worked for three months on account of weakness.

Physical Examination. A well-developed emaciated white male with pronounced anemia. Thorax symmetrical, dullness over left upper chest posteriorly and at angle of scapula on right. Extremely fine crepitant rales in first intercostal space anteriorly on left, and typical rales in both axillae. Breath sounds distant posteriorly over upper portion both sides of chest.

Temp., 37–38°, with afternoon rises; pulse, 75–110; resp., 22–36; R.B.C., 3,600,000; Hgb., 70 per cent.

Roentgen Examination (Fig. 4). Chest slightly asymmetrical. Right side contracted. Mediastinal shadow widened. Cavity at left apex. Large hilar mass on left with radiations and large, dense shadows scattered along bronchial branches. Mottling entire right side, particularly the upper lobe. Nodule at right base near heart.

One month later the roentgen examination gave the following fiindings: Cavity left apex. Extension of hilar shadows. Small nodule seventh interspace and directly below it, another in the ninth. Mottled density on right side at base.

Autopsy. Large mass at left hilum, many firm tumor masses in upper left lobe. A few in lower lobe. Nodules throughout entire right lung. Cylindric-cell carcinoma. Caseous mediastinal glands. Tuberculosis both sides with cavity in left apex.

CASE IV. Male, dancing instructor, aged fifty-two.

Entered Tuberculosis Sanatorium of Cleveland City Hospital Aug. 17, 1922, and died Oct. 21, 1922. His complaint was weakness and pulmonary hemorrhages. His past history was negative except for diphtheria in childhood; he denied luetic infection.

Complaint. Present illness started six months ago with loss of strength and cough, no fever, no night sweats. One month ago he had lost 10 lbs. in weight and three weeks ago he had his first hemorrhage, "about a glass and a half of blood." Two days ago he had another hemorrhage.

Physical Examination, Oct. 14, 1922. A well-developed white male, quite anemic and emaciated with dry and inelastic atrophic skin. Pupils sluggish, right slightly irregular. The right supra-claviular and infra-clavicular fossae deeper than the left. Right upper chest flatter than the left. No undulation on left but some on the right, however, the costal margins flare but slightly. Percussion note impaired over left upper chest anteriorly and posteriorly and over right hilus posteriorly. Breath sounds distant but high pitched with prolonged expiration over left upper chest. No rales heard anywhere. During the patient's stay in the sanatorium he had repeated pulmonary hemorrhages varying in amount from 1½ ounces to 1½ pints. Thirteen sputum examinations were nega-

tive for tubercle bacilli. Blood Wassermann, 4 plus. Blood pressure, 114/70. Temperature curve was irregular, sometimes as high as 38.5°C., with intervals of several days in which there was absence of fever.

Roentgen Examination, June 1, 1922 (Fig. 5), shows triangular-shaped shadow in the left hilum with base toward the median line. At the apex, there appears to be a separate nodule about three-fourths of an inch in diameter. Slight veiling of upper lobe of left lung. Lower half about as clear as corresponding portion of right. Heart was displaced.

We are indebted to Dr. J. E. Olivenbaum for this plate. The patient did not come under our observation until four months later.

Four months later, Oct. 14, 1922 (Fig. 6), there was marked asymmetry of chest. Left side contracted. Uniformly dense in middle portion, tainning out slightly toward apex and very markedly toward left costophrenic angle, which is comparatively clear.

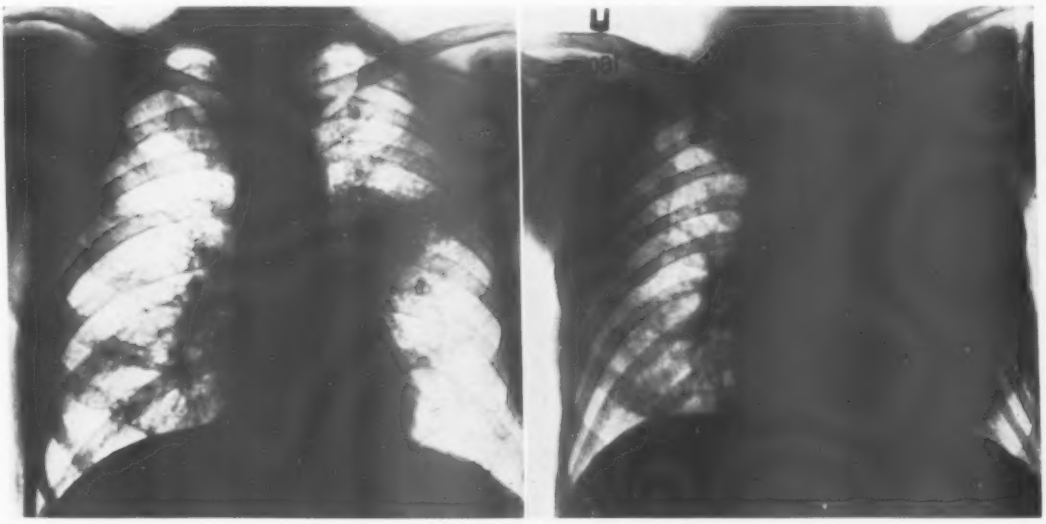
Autopsy. Several small nodules in left main bronchus. Occlusion of bronchus to left upper lobe by a pulpy mass 5 × 3 cm. in diameter. Dilatation of bronchi beyond occlusion, and atelectasis of lung. Metastasis to a paratracheal lymph node, 3 × 2 × 2 cm. in diameter. Bronchial carcinoma.

CASE V. Male, farm laborer, aged forty-three.

Entered Tuberculosis Sanatorium of Cleveland City Hospital, Jan. 7, 1923, and died March 29, 1923.

Complaint. Pain in chest, cough, weakness, fever, night sweats and shortness of breath. The onset of these symptoms was three months ago and they had increased in severity. No history of pneumonia.

Physical Examination. A white male in fair state of nutrition. Whole left chest moves less than right. Left apex fairly resonant but rest of chest is dull, with absence of breath sounds or distant tubular breathing. Tactile fremitus diminished throughout left chest, absent at base.



FIGS. 5 and 6. Case IV.

Irregular fever, skin dry, lips parched. Pus of pea soup color was aspirated on two different occasions—15 c.c. and 160 c.c. The patient was transferred to surgical service and a rib resection done Jan. 16, 1923. A small amount of pus was found. Drainage was never profuse and for two weeks before death the discharge was a brownish thin fluid. The sputum and the pus from the chest were negative for tubercle bacilli. Left chest was flat to percussion but no further fluid obtained when needled.

Temp., 36–39°C.; pulse, 65–138; resp., 18–40; hgb., 85 per cent.

Roentgen Examination. Chest asymmetrical. Left side contracted, and heart retracted to left. Left side uniformly opaque, except for slight thinning out

toward apex and base where drainage tube has been inserted. Right side comparatively clear.

Two months later. Chest asymmetrical. Left side now larger than right, and mediastinal contents displaced markedly to the right. Left side uniformly dense.

Autopsy. Obliteration left pleural cavity by dense adhesions. Heart and mediastinum displaced 5 cm. to right. Entire left lung solid, airless, with area of necrosis in which was found a drainage tube. Nodules on visceral and parietal pleura. Pulmonary vein filled to its point of entrance into the auricle with tumor tissue.

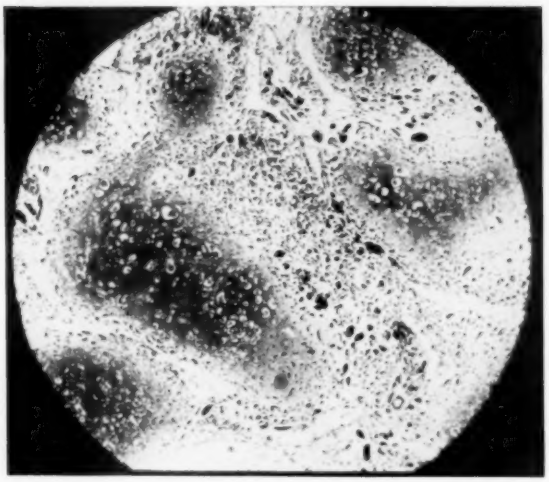


FIG. 7. Case VI.

Carcinoma—primary in lung with metastasis to right adrenal, and to mediastinal and prevertebral lymph nodes.

CASE VI. Male, colored, laborer, aged forty-one.

Entered Cleveland City Hospital Jan. 22, 1923, and died Feb. 13, 1923.

Complaint. Pain in right chest, cough, bloody expectoration, shortness of breath, loss of weight, loss of appetite, insomnia, and weakness. These symptoms began ten weeks ago and he has gradually grown worse. Had malaria and swamp fever during childhood in Mississippi. Had chancre twenty years ago, pleurisy four years ago and influenza three years ago.

Physical Examination. Well-developed emaciated male who is restless and uncomfortable; dyspneic, but not cyanotic. The right side of the thorax is decidedly larger than the left. Motion on the right side markedly restricted. Slight displacement of the heart to the left. Dullness on the left from clavicle downward. Tactile fremitus markedly diminished over dull area and breath sounds are absent. Diminution of vital capacity marked. Liver dullness four finger breadths below costal margin but no nodulation felt. Abdomen distended with free fluid. The veins of the right arm distended and both sides of face edematous. Superficial hyperesthesia extends from right nipple down to umbilicus. This hyperesthesia extends laterally on right to mid-clavicular line and to the posterior axillary line on the left.

Temp., 36.5° C. to 38.6° C.; pulse, 80–120; resp., 20–32; urine, neg.; Wass., neg., W.B.C., 9,200 to 11,400; R.B.C., 3,584,000; Hgb., 55 per cent., vital capacity, (sitting) 1,200.

Biopsy. Fragments of tissue aspirated by needle diagnosed chondrosarcoma by Dr. H. T. Karsner.

Roentgen Examination. Shows a massive uniform density of most of the right chest. The density fades out toward the costophrenic angle. The upper border of density is at the level of the fourth interspace posteriorly. It is sharply outlined and curved with the convexity upward. The lung field above is comparatively clear, except for moderate density compared with the corresponding field in the left lung. The left lung shows nothing unusual.

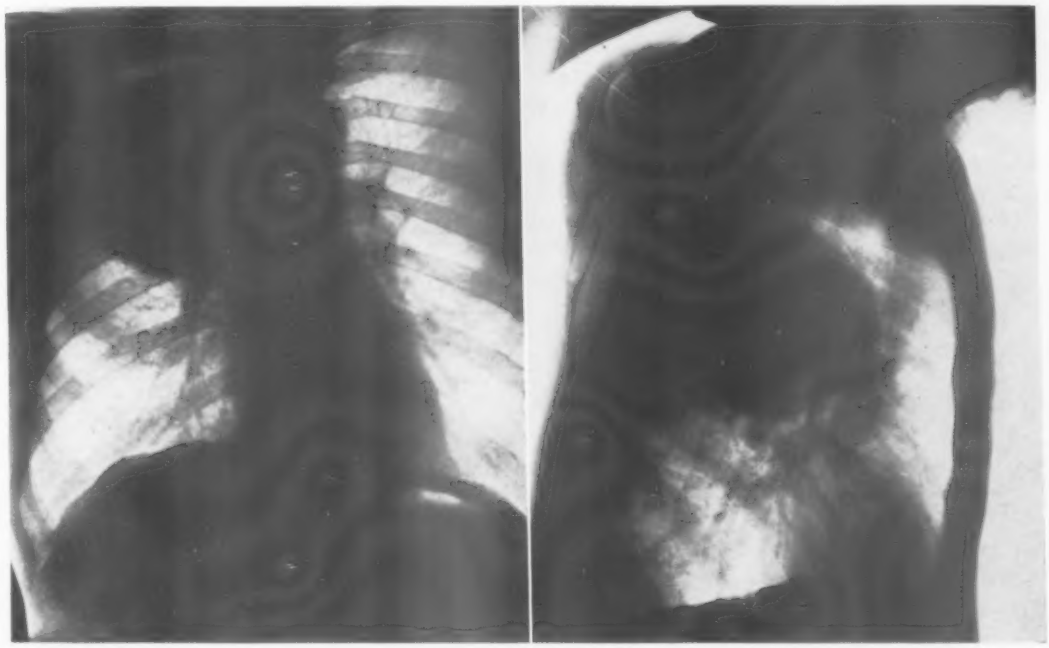
Figure 7 is a high power microphotograph of the tumor showing area of embryonic cartilage cells and also mature cells undergoing calcification.

Autopsy. Chondrosarcoma involving pleura, middle and lower lobes of right lung. Displacement of heart and mediastinum to left. Displacement of diaphragm downward. Compression of both cavae. No metastases.

CASE VII. Male, newspaper editor, aged thirty-three.

Complaint. Pain in right upper chest, of five year's duration, worse when tired or during change of weather. Three years ago consulted well-known internist and on his negative findings patient took up Christian Science, "with much relief from pain and improvement in general health."

Physical Findings. Negative, March, 1919. No physical signs detectable until



FIGS. 8 and 9. Case VII.

five months after the presence of the tumor was discovered by routine roentgen examination.

Roentgen Examination. March, 1919 (Fig. 8). The plate shows asymmetry of chest. Right side contracted. There is a circumscribed globular shadow of even density about 12 cm. in diameter occupying the location of the lower portion of the upper right lobe. The left side of the chest is negative.

The lateral view (Fig. 9) shows this spherical mass located toward the posterior part of the chest. The border is smooth and sharply demarcated. This case was examined by some of the leading internists of the country immediately after these plates were made and no physical signs of a tumor could be found.

We are indebted to Dr. C. S. Hoover of Alliance for the subsequent roentgenograms and the history of this case.

Ten months later the roentgenogram showed increase in size of this growth and the development of a similar tumor springing from the hilum below. The oblique view shows the lower tumor more clearly.

Patient was operated upon by Dr. George Heuer of Philadelphia in May, 1920. A large vascular tumor was found which could not be removed. Large needle

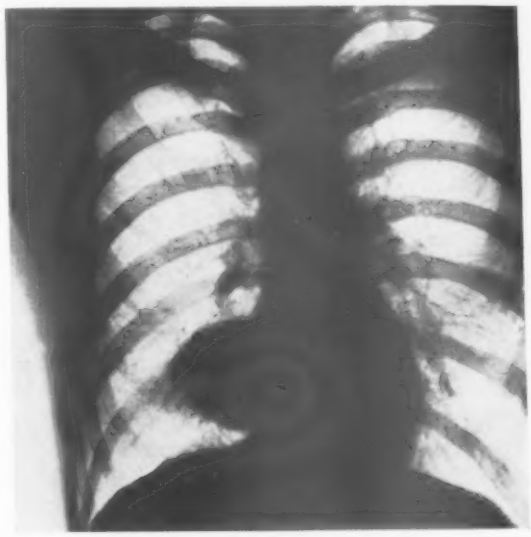


FIG. 10. Case VIII.

was inserted and tissue aspirated for biopsy, and was diagnosed endothelioma (Bloodgood and McCallum).

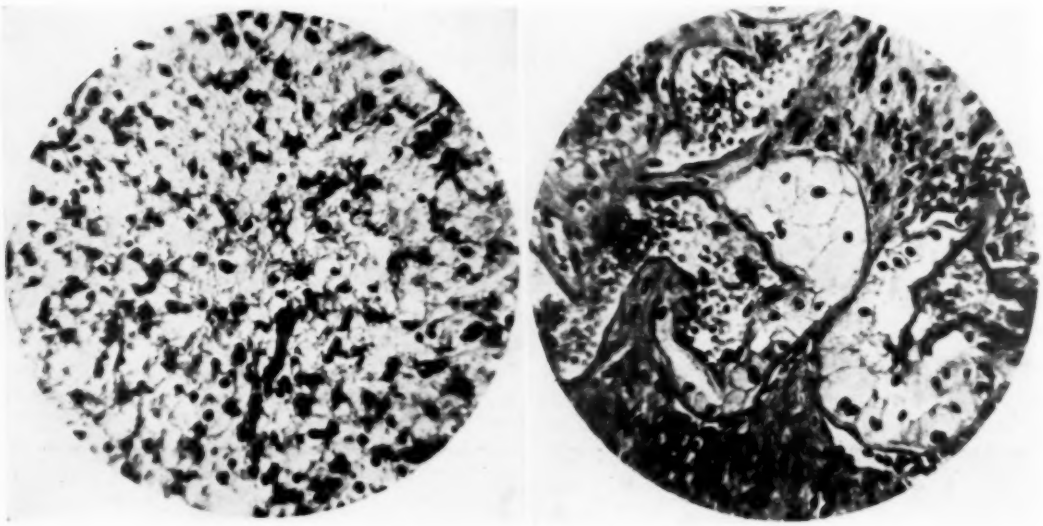
The last plate made fifteen months later than Figure 8 shows that the upper tumor fills almost the entire right side of the chest except the apex. The lower tumor extends almost to the costophrenic angle. There is a small area of aereated lung at the lateral chest wall between the upper and lower tumors. The heart and aorta are displaced markedly to the left. The left lung remains clear.

Patient died July 8, 1920.

Autopsy. Tumor mass filled up entire right chest displacing diaphragm downward and the heart to left.

were negative. The mass in the chest was discovered eight months ago when a film was taken for other reasons. A needle was introduced into the growth in hopes of finding fluid if it were a cyst. None was obtained. The needle puncture produced a sharp shooting pain, extremely severe in the right lower abdomen, of the same type experienced in the attacks for the past fifteen years.

Figure 10 shows a dense rounded mass about two inches in diameter, arising apparently from the tenth rib on the right side close to the spine. The lateral view,



FIGS. 11 and 12. Case VIII.

CASE VIII. Male, physician, aged twenty-nine. Jan. 15, 1919.

Complaint. Fifteen years ago patient had a sharp stabbing pain in the lower right quadrant of abdomen. The attack lasted ½ hour, leaving the region tender and sore for a few days. Similar attacks followed every three or four months. Violent exercise or sudden chilling would precipitate an attack. If a slight blow was received in mid-portion of the chest, pain was felt in the region of the 10th dorsal vertebra and at times radiated to lower right abdomen. There was never any fever. Seven years ago a normal appendix was removed with no relief of symptoms. It was impossible to rest or sleep in any position except flat on the abdomen. Roentgen examinations of the gastrointestinal tract shows a circumscribed border with apparently a capsule, there being a very thin zone of transparency, on the outside of which there was an adjoining thin line of density. On account of the smooth contour from all aspects and the long duration indicated by the history, a diagnosis of benign tumor was made. The possibility of cyst had been eliminated previously by puncture.

The tumor was removed with complete relief of symptoms. The pathological diagnosis was xanthoma by Drs. Bloodgood and MacCallum.

Figure 11 shows a microphotograph of the tumor.

Figure 12 shows the high power microphotograph of typical foam cells.

We are indebted to Dr. Geo. Heuer for the use of these beautiful microphotographs.

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ABSTRACT OF DISCUSSION

Dr. Baetjer stated that he had found it quite impossible to differentiate the infiltrating type of carcinoma of the lung from tuberculosis or resolving pneumonia, by the roentgen evidence alone. He cited 6 cases of the infiltrating type of the disease in which the roentgenologist's report was wrong. The diagnosis in these cases must be made, if made at all, upon other than the roentgen findings.

Dr. Pancoast described the progress of the lesion in a case of epithelioma of the apical pleura. It produces an early erosion of the first three ribs and later an erosion of lower ribs and the vertebrae. The patient is generally referred to the roentgenologist because of pain in the shoulder, and cervical ribs may be suspected.

Very early there is only slight opacity in the apex and later increasing with uniform density until it appears to involve the entire lung. It is in reality, however, a tumor of the pleura. The symptoms of this condition often simulate tumor of the spinal cord.

Dr. Holmes emphasized the fact that although it may be impossible to make a definite diagnosis between tumor, tuberculosis, and other diseases, still the roentgen examination does show the presence of a lesion, and directs the clinician's attention to it. This is of great importance in those cases that give no clinical evidence of their presence.

DANGER IN PRESCRIBING BARIUM SULPHATE

It has been brought to the attention of the Safety Committee of the American Roentgen Ray Society that several deaths have occurred throughout the country during past years because of the use in roentgen examinations of the digestive tract of soluble or impure barium preparations instead of pure barium sulphate, which is insoluble. Barium sulphate for internal use must be specially prepared in order to remove all soluble barium salts, such as the chloride, etc.

Barium sulphate is a substance not often prescribed and seldom called for by individuals in drug stores. On the other hand, barium sulphide is a well-known depilatory, is easily obtained from any drug store and is extremely poisonous when taken internally.

In order to avoid the possibility of the occurrence of mistakes in the future, it is suggested by the Safety Committee that no prescriptions be written for barium sulphate and that patients be not instructed to obtain this substance from drug stores for internal use. If it is considered absolutely necessary to give a prescription it should be labeled plainly as follows: "This is to be taken internally and must be filled only with barium sulphate specially prepared for internal use." Another alternative is to prescribe bismuth subcarbonate which is satisfactory as an opaque medium for roentgen examinations and which does not present the same opportunity for mistakes as is the case with barium sulphate. There is, of course, no intention to discourage the use of barium sulphate in roentgen laboratories of institutions or in the private offices of roentgenologists.

A CASE OF HODGKIN'S DISEASE, WITH LATE DEVELOPMENT OF SACROILIAC DISEASE, CURED BY ROENTGEN TREATMENT*

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THIS case is of especial interest because of the extensive glandular and mediastinal involvement, which gradually disappeared completely under roentgen-ray treatment. After all glandular disease had disappeared, a tumor appeared over the left hip, which seemingly was associated with a destructive disease of the sacroiliac joint. This tumor in the hip and the sacroiliac disease disappeared almost like magic after a single exposure to the roentgen rays. The term "cure" is, of course, used in the sense that the visible disease has disappeared, for no one has yet determined how many years must pass before a case of Hodgkin's disease can be considered really cured. In fact, we are not yet sure whether any of them are permanently cured. We present the case more for criticism and discussion than as representing any special skill or technique on our part.

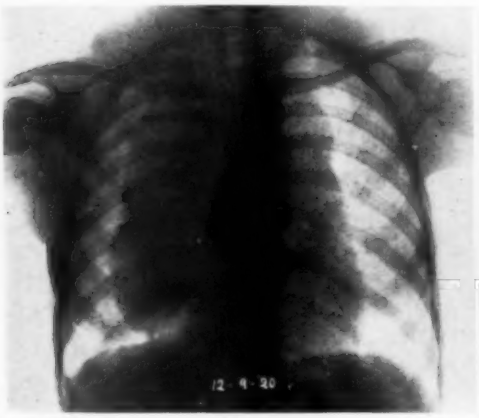

FIG. 1. Dec. 9, 1920. Shows extensive mediastinal tumor; also the tumor tissue in the right axilla and in both sides of the neck before treatment.

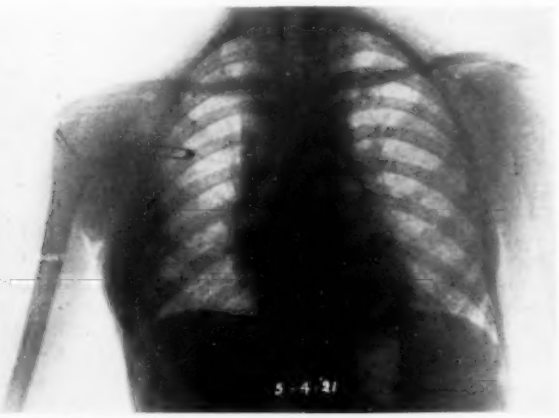

FIG. 2. May 4, 1921. Shows remains of mediastinal tumor five months after beginning treatment, the tumor tissue being reduced to about one-tenth.

Briefly, the history of this case is as follows:

Female, aged sixteen, was admitted to the Medical Service of the Misericordia Hospital, under Dr. W. F. Monaghan, who referred her to the roentgen-ray department for examination and treatment December 9, 1920. Swelling of the glands on the right side of the neck had been noticed by the patient first during December, 1919. Under local applications they disappeared and returned again to a considerable size by July, 1920. The glands became progressively larger and rapidly involved also the left side of the neck and both axillae. They were not painful and the patient had no subjective symptoms.

The patient was of small stature, somewhat emaciated, pale or anemic in appearance, with extensive lymphatic tumors in the right side of the neck, consisting of isolated glands of uniform consistency, making a mass the size of a fist. There was about half as much glandular tissue on the left side of the neck, and a group of glands in each axilla, making a mass about the size of a hen's egg, larger on the right than the left. None was palpable in the abdomen or groins. There was no evidence of softening and no tenderness. There were none of the appearances usually found in tuberculous adenitis. There had been no menstruation since December, 1919, a period of seven months.

* Read at the Fifth Annual Meeting, Eastern Section, AMERICAN ROENTGEN RAY SOCIETY, Atlantic City, N. J., Jan. 24–26, 1924.

The sputum showed no tubercle bacilli. The examination of the nose, throat and tonsils by Dr. McCarthy showed nothing abnormal.

Roentgen examination showed a large mediastinal tumor mass equal nearly to that of the patient's head. The tumor shadow was continuous with the shadow of the heart and together with the cardiac shadow occupied about one-half of the chest cavity. The outline was smooth and sharply defined. There was no evidence of pulsation. The lungs were clear. The heart shadow was normal.

The Wassermann test was negative. The blood examinations were as follows:

Dec. 9, 1920. R.B.C. 3,430,000; W.B.C. 14,200; H., 65; P. 71; T. 5; Lymph. 22; E. 2. June 22, 1921. R.B.C. 3,830,000; W.B.C. 8,200; H. 80; Poly. 82; S.L. 10; L.L. 8. Sept. 20, 1922. R.B.C. 4,050,000; W.B.C. 8,200; H. 78; Dr. Kenney. Jan. 16, 1923. R.B.C. 3,780,000; W.B.C. 5,600; H. 75; P. 64; T. 2; Lym. 32; E. 2.

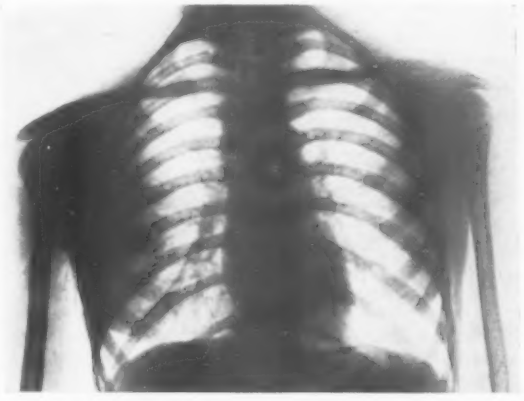

FIG. 3. June 6, 1923. All palpable tumor tissue has disappeared and the mediastinum is normal. Patient at this time returned with a tumor on the outer and posterior portion of the thigh. See Figure 4.

A section of the cervical glands studied by Dr. J. D. Paul showed Hodgkin's disease.

The treatment consisted of the application of roentgen rays over each of the glandular areas, using a 9 in. parallel spark gap, 5 ma. at 40 cm. distance for 40 min., with a filtration equivalent to 6 mm. of aluminum. Each side of the neck, the axillae and the anterior and posterior surfaces of the chest were exposed, cross-firing as much as possible on the mediastinal tumor. Five applications were made over each area within a period of eighteen months.

There was a progressive reduction of the tumor tissue, and a progressive improvement in the patient's general health. Her appetite improved, weight and strength increased and her pallor disappeared. Her menses reappeared April, 1921, about nine months after beginning treatment, despite the fact that two applications of the rays had been made over the abdomen.

FIG. 4. June 6, 1923. Shows the distention under the fascia lata. Tumor felt quite solid. No fluctuation. See Figure 5.

On June 22, 1921, or eleven months after beginning treatment there was no palpable disease. The mediastinum still showed tumor tissue, which had been reduced about two-thirds. April 26, 1922, the patient seemed to be well, though there was still slight evidence of disease in the upper mediastinum. The patient then remained apparently well for about a year.

June 6, 1923, two years after beginning treatment and one year after stopping active treatment, she returned for examination on account of a tumor which had formed over her left hip, lying posterior to the greater trochanter, about the size of a small banana, but quite hard, suggesting bone. Roentgen examination showed no disease of the hip bones, and the tumor shadow was of the density of soft tissue. It then occurred to us that perhaps we were dealing with a drainage abscess and we made an examination of the sacroiliac region. We found a destructive disease of the upper portion of the left sacroiliac joint, involving an area about 1 in. in diameter. It was sharply defined and did not have the appearance of tuberculosis, which is usually not sharply defined and is associated with atrophy of the adjacent bone. At the time, however, we looked upon it as tuberculosis, because we could not give it any other name. At that time, there were no palpable lymph nodes and the mediastinal tumor had entirely disappeared.

On June 15, 1923, knowing nothing better to do, we gave a dose of roentgen rays similar to that described above. No treatment was given to the tumor on the left thigh, which was probably a "cold abscess." When she returned on August 9, the tumor had entirely disappeared and roentgen examination of the sacroiliac region showed the bone healed. A second dose of roentgen rays was applied on this day before the film had been developed.

FIG. 5. June 6, 1923. Shows destruction of the upper portion of the sacrum and extending from the inner border of the right sacroiliac joint to the left sacroiliac joint where the disease involves 1 in. of the inner portion of the left ilium. The disease resembles tuberculosis except that it is sharply defined.

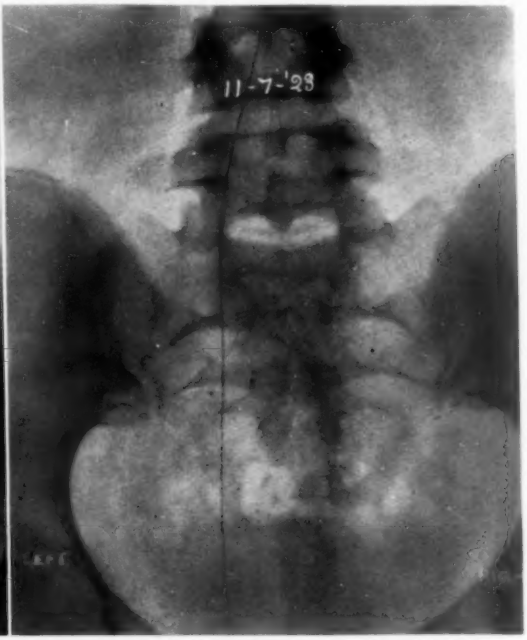

FIG. 6. Nov. 7, 1923. Shows restoration of the sacrum and sacroiliac region to normal after one application of the roentgen rays, no treatment having been given over the femur, this single treatment consisting of a 9-in. spark gap with 5-ma., 40-min. exposure at 40 cm. and filtered through 6 mm. of aluminum. At this time the patient seems to be thoroughly healthy in every respect. The response seems too prompt to be considered tuberculous.

Remarks. This patient had the typical clinical and roentgenographic appearance of Hodgkin's disease. It has disappeared completely (apparently) under the influence of the roentgen rays. This disappearance under roentgenotherapy is common.

The appearance of the sacroiliac disease and a gluteal abscess afterwards, however, is not common, and the rapid disappearance of the sacroiliac disease and the gluteal abscess after about two-thirds of a full erythema dose of roentgen rays is truly remarkable. Dr. O'Boyle has reviewed

the literature and can find no similar case on record.

If this bone disease is tuberculosis, we would have an argument in favor of early roentgen treatment of such disease, instead of waiting for all other methods to fail and only using the rays in the most chronic and obstinate cases of bone or joint tuberculosis. If this bone disease were a part of the Hodgkin's disease, the rapid response would not be remarkable, but one would have to change the entire idea of Hodgkin's disease. If others have had similar experiences, they should be recorded.

DISCUSSION

Dr. Pancoast, Philadelphia. I have seen what I thought was bone involvement in Hodgkin's disease on one occasion a number of years ago, and the appearance was rarefaction of the bones, very much as indicated in the slide shown. It occurred around the shoulder girdle, and that patient had very severe pain in his arm and around the shoulder. He was in the terminal stage of Hodgkin's disease, having been one of the glandular enlargement cases, and died not very long afterwards. I think in another instance I have seen it, but I am not certain. I know that case particularly well, and I have never seen any reports of similar cases since. I thought since that time that I was possibly mistaken in taking that for Hodgkin's disease, but I am very glad to hear of another case. I believe it can occur.

Dr. Quick, New York City. We had a case sent to us last year by an orthopedic surgeon with a tentative diagnosis of bone sarcoma in the dorsal region. On going into the history we found that that man had been treated three years previously and for some time after that at one of the other hospitals in town for Hodgkins' disease, and nodes had been obtained which verified the diagnosis. We verified it subsequently, so there was no question as to the original condition. The patient had been treated very efficiently. When she came in she had severe pain with clinical evidences of bone involvement in the mid-dorsal region. The plate showed definite destruction of the bone. I felt rather suspicious of the diagnosis as sent, in view of the previous Hodgkin's history. Dr. Herendeen was very certain it was not an osteogenic tumor and that it was probably not tuberculous. It had rather a hollowed out appearance. I presume the explanation was just this, that the patient had been well-treated originally; that the huge mediastinal mass had contracted and when the disease lighted up locally again it could not proceed anteriorly; in other words the dense fibrous tissue held it in that direction and there was a pressure or erosion of the bone from it. We had hoped for several months to get an autopsy but were unable to do so.

Dr. Stern, New York City. We have in the Roosevelt Hospital at the present time a patient with very extensive Hodgkin's disease which presented abscesses on the dorsum of the foot which were finally opened and formed at one time a draining sinus. There was local destruction of the second metatarsal bone. The glands are improving very satisfactorily. We have recently radiated this lesion in the foot, and at the present time it looks as though we are obtaining a very definite result from that.

Dr. Holmes, Boston. I have not had any cases exactly like these, but we have seen some very unusual complications following Hodgkin's disease that have been treated over a long period of time; that is, we have seen things we thought resulted from an enlargement of the lymphoid tissue in unusual conditions. One patient had severe pain down the leg, but there was no evidence of anything in the bone such as Dr. O'Boyle's case shows. We did find later a growth in the spinal canal which pressed on the nerve root. That was proven by operation, and that the enlargement was a true Hodgkins' enlargement.

Dr. Pfahler: In the bone?

Dr. Holmes: No, it was in the spinal canal and pressed on the nerve root and gave very severe pain. We have also had two cases which developed brain symptoms resembling very much epileptic attacks, one of which was proven by operation to have enlargement of the lymphoid tissue of the brain, which is not supposed to be there, but it was found, and proved to be Hodgkin's disease. I think we must be on the lookout for unusual occurrences in these cases that have been irradiated over a long period of time. In this case reported, might not the bone destruction be due to pressure from a mass of glands in the pelvis, rather than to disease of the bone?

Dr. Pfahler: There were no glands in the pelvis, the patient had never been treated down there and there were none ever palpable; we looked for them.

Dr. Holmes: Do you think you could find then if they were there?

Dr. Pfahler: Certainly, any that were large enough to cause pressure.

Dr. Holmes: We have had cases come to autopsy with masses of glands deep down in the pelvis that we were not able to feel while the patient was alive; and then glands in the

spinal canal certainly would not be palpable and yet would produce pressure and possibly necrosis in the bone. The patient that I mentioned came to operation because we radiated in the wrong place; his gland was much higher up. If we had radiated in the right place we ought to have reduced that gland.

Dr. Herendeen, New York City. I can recall two cases in which there was gross destruction of bone immediately beneath the mass of nodes of Hodgkin's disease. In one case the destruction occurred in the lumbar vertebrae with a mass of retro-peritoneal nodes that infiltrated also through all coats of the aorta. A section revealed multiple nodular enlargement. There was a large area of gross bone destruction, apparently not due to pressure, but to direct invasion. Another case came to autopsy and showed a large mass of nodes overlying an area of bone destruction in the pelvis. Recently I saw a case of Hodgkin's disease verified by a section of a node taken from the supraclavicular region, in which apparently metastasis had occurred. I use the word metastasis because there was no well-marked mass overlying a large area of destruction in the external condyle of the right femur. This patient's pain was relieved to a great extent by a small dose of roentgen ray over that area.

Dr. Manges, Philadelphia. I want to cite a case that seems to be very much along this line. There was one added feature to it that has not been mentioned in connection with the other cases. A young man who undoubtedly had Hodgkin's disease, verified by a study of the section, and who responded very promptly to roentgen treatment and to all appearances was cured; about 6 months later, perhaps less than that, returned to the hospital running a rather high temperature. There were absolutely no physical signs of any lesion in the chest or elsewhere. Pain in the back developed very rapidly, and following that there developed paralysis of the lower limbs and of the bladder and colon functions. I examined the spine, the lumbar and the dorsal regions very carefully, and could find absolutely no sign of any bone change. Paralysis became constantly more and more marked. The temperature gradually came down. Infection of the bladder, and in fact of the entire urinary tract, ensued and the patient died. I begged them to let me treat the patient or at least to treat the back, thinking that he probably had a spinal tumor, but I must admit that I did not associate it with the original condition of the Hodgkin's disease, but I think in view of what has been discussed here, it must have been the same thing. I would like to know if these other cases reported of spinal lesions in these cases have been associated with high temperature?

Dr. Pancoast, Philadelphia. I think we have all seen peculiar manifestations of Hodgkin's disease. Dr. Holmes mentioned a case in which there was an intra-spinal metastasis or growth of Hodgkin's. I have seen the same condition requiring a laminectomy, which proved the presence of the condition. Another case in which, after the disappearance of all glands, the patient suddenly developed exophthalmus on the other side, which also disappeared after radiation. It has been my experience that herpes zoster is a very frequent complication in the course of Hodgkin's disease, probably due to some nerve pressure, and even after we are apparently rid of all the growths which are visualized by the roentgen ray or discovered by palpation. There seems to be no end to the number of manifestations, and I feel very firmly convinced that we do have the bone manifestations. I think we should always make sure that the condition is Hodgkin's disease by resorting to biopsy. I do not think there is any danger in the removal of a gland which is near the surface in order to have it examined by a competent pathologist.

These observations indicate that radiation is capable of restraining the growth of tumor cells without causing either autolysis or necrosis, and of transforming functionless lawless cell growths into more organized and functioning tissues. This action is exerted also on proliferating connective tissue and on a wide variety of simple inflammatory and functional hyperplasias, and forms the basis of radiotherapy in many diseases outside the realm of tumors. If th esedeductions are correct, then this property of radiation is an extremely important addition to general therapeutics. For the first time in the history of medicine we are in possession of an agent which will control the growth of connective tissue. This tissue is the main element in the lesion which underlies many chronic and practically irremediable diseases, so that the search for such an agent has been the faint hope of pathologists for many decades. Aside from the practical question of its successful application, this property of radiation is of very great scientific interest. For this property we may safely conclude that its action is both specific and selective. Normal tissues and organs are distinctly less sensitive than neoplastic and hyperplastic. Even normal lymph-nodes resist radiation when inflammatory hyperplasias yield readily. We may also claim that its action is SECUNDUM NATURAM, *in that when properly employed it inhibits that reaction in excess which Weigert emphasized as the significant physiological element in productive inflammation and which exists also in many neoplasms. We have thus reviewed three main principles of radiation therapy which appear to be fundamentally different, each of which is selective, specific and tends to support natural processes of defense. These are:*

From An Analysis of Radiation Therapy in Cancer. The Mütter Lecture by James Ewing, in Radium Report of the Memorial Hospital. (Second Series, 1923.)

PRIMARY CARCINOMA OF THE GASTROINTESTINAL TRACT ACCOMPANIED BY BONE METASTASIS*

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IT has long been known that tumors involving certain organs have a tendency to metastasize to the osseous system. Tumors of the thyroid, prostate, and breast, and hypernephroma are frequently accompanied by bone metastasis.

Carcinoma of the gastrointestinal tract, however, is not included in the tumors that usually cause bone metastasis, and the literature is very limited in dealing with this subject.

From the work done at the Mayo Clinic by Dr. Moore one case of metastatic carcinoma of the bones following carcinoma of the gastrointestinal tract has been reported. His series covers 65 cases distributed as follows: Breast, 36; prostate, 11; kidney, 7; thyroid, 7; vulva, 1; sigmoid, 1; uterus, 1; abnormal masses of unknown origin, 3; primary source not discovered, 3.

Kaufmann, in his treatise on gastrointestinal carcinoma, gives the following percentages with regard to bone metastasis: 309 cases of carcinoma of the stomach showed 2.5 per cent bone metastasis; 101 cases of esophageal carcinoma showed 6.9 per cent; 57 cases of carcinoma of the rectum showed 10.5 per cent.

Schlesingers reports 54 cases with metastatic growths in the vertebrae. The primary tumors were as follows: Breast, 10; esophagus, 9; thyroid, 9; uterus, 6; bronchus, 5; stomach, 4; prostate, 3; gall-bladder, 2; ovary, 1; sigmoid, 1; rectum, 1; kidney, 1; pancreas, 1.

Baetjer and Waters in their book on "Diseases of the Bones and Joints" do not mention the gastrointestinal tract in their discussion of bone metastasis. Ewing in "Neoplastic Diseases" mentions only briefly the possibility of bone metastasis accompanying gastrointestinal carcinoma.

In reviewing the literature, a total of 41 cases showing osseous metastasis following carcinoma of the gastrointestinal tract was found. The 41 cases were distributed as follows: Stomach, 32; gall-bladder, 3; rectum, 2; bile-ducts, 1; appendix, 1; pancreas, 1; colon, 1. In 17 of the 41 cases a definite history of pain in the bones was given, and in 4 of the cases fractures were present. The vertebrae seemed to be the favorite site of metastasis, and the lesions were, as a rule, multiple. Twenty-five of the reported cases showed vertebral metastasis. In only 13 of the cases was only one bone involved. It seems that the bones distal to the elbow and knee are very infrequently the site of metastasis. In none of the cases reported did we find mention of lesions in the ulna, radius, tibia or fibula. The ages of the patients ranged from twenty-one to sixty-four, the average being forty-three. The sex was named in 25 of the cases, divided, 17 males and 8 females.

Carcinoma of the esophagus is characterized by the variety and obscurity of its symptoms, peculiarities of the structures and its high mortality. About 75 per cent of the cases occur in males, and the average age is around fifty. Kaufmann, however, reports a case in a woman of ninety, and Himnan in a girl of fifteen. The favorite points of predilection are the cricoid, the aortic arch, tracheal bifurcation, crossing of the left bronchus, and the cardia. Anomalies in the mucous membrane of the esophagus such as the interruption of the squamous epithelium by the islands of mucous glands resembling glands like those of the stomach, make the two conditions very similar and hard to differentiate microscopically.

The usual types are: (1) The flat infiltrating ulcer; (2) the bulky polypoid of globular mass; (3) diffuse infiltration which may encircle the entire esophagus. The growth is prone to extend into the larynx and stomach and may even rupture into the trachea. Early and extensive metastasis usually occurs, probably due to the abundant blood and lymphatic supply. The most common metastasis is by extension. Dürr, however, reports a case of metastasis into the muscles over the pubic bone.

* Read at the Twenty-fourth Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Chicago, Ill., Sept. 18–21, 1923.

In our series of cases we have encountered one primary carcinoma of the esophagus with bone metastasis. The secondary lesions were located in the lumbar vertebrae and obviously did not occur by extension.

CASE I. Male, white, aged sixty, entered St. Luke's Hospital complaining of difficulty in swallowing solid foods. Liquids were swallowed with practically no difficulty or feeling of fullness. The dysphagia came on very acutely; three weeks prior to admission to the hospital he had experienced no difficulty. The dysphagia was accompanied by a great deal of pain which seemed to be relieved after swallowing the initial mouthful. The family history was of no importance. The Wassermann reaction was negative. The blood count was as follows: 3,930,000 red cells, 9,400 whites, and 85 per cent hemoglobin. The differential count showed 21 per cent small lymphocytes, 2 per cent transitionals and 68 polymorphonuclears. Blood pressure, systolic 150, diastolic 80. The physical examination revealed an enlarged liver which extended downward two finger breadths below the costal margin, and which was very tender on palpation. There were a few small palpable lymph glands in the cervical region. The lower lumbar spine was very tender on palpation. The reflexes were normal. The prostate was normal on palpation.

The day following admission a roentgen-ray examination of the gastrointestinal tract was ordered.

Roentgen Findings. The upper half of the esophagus is dilated to about twice its normal size. There is a definite stricture involving the middle third of the esophagus. The lumen of the stricture is very irregular and measures 1 cm. in diameter and is about 2 in. long. The lesion has the physical characteristics of malignancy.

While in the hospital the patient complained of severe pain in the lumbar spine. The following day an orthopedist was called in and carefully examined the spine. At his suggestion, a roentgen examination was made. The report was as follows: "There are definite areas of bone rarefaction which have the appearance of destruction involving the third and fourth lumbar vertebrae. The articular surfaces of the vertebrae seem normal in outline. The pathology seems confined to the bodies, which have a moth-eaten appearance. In lieu of the carcinoma of the esophagus I am inclined to believe the process is due to metastatic malignancy."

The difficulty in swallowing became progressively worse. The patient finally refused all solid foods and only after much persuasion would he attempt to swallow liquids. His condition also became progressively worse and on November 7 he died.

The post-mortem findings were as follows: Carcinoma involving the middle third of the esophagus with necrosis. Metastatic carcinoma of the liver, dorsal and lumbar spine, ribs, lungs, and retroperitoneal, tracheo-bronchial, posterior mediastinal and biliary lymph glands.

The *stomach* is the most frequent site of cancer in males. In 1912, a total of 46,534 people died of cancer in the United States. Of this number 39.75 per cent or 18,517 had cancer of the stomach. According to the United States census of 1911, 61.2 years seems to be the average age in which cancer of the stomach occurs. It may occur, however, at a very early date. Osler and McCrae report 10 cases in children under ten years of age. The adenocarcinoma seems to be the type that usually attacks the young. Cullingworth reports an adenoma in an infant five weeks old. According to certain statistics, about 60 per cent of all stomach carcinomata occur at the pylorus, 20 per cent along the lesser curvature and 20 per cent along the greater curvature. The fundus is rarely involved. In Welsh's report of 1,200 cases, the distribution was as follows: Pylorus 60.8 per cent; lesser curvature 11.4 per cent; cardia 8 per cent; posterior wall 5.2 per cent; diffuse 4.7 per cent; multiple tumors 3.5 per cent; greater curvature 3.6 per cent; anterior wall 2.3 per cent; fundus 1.5 per cent.

Kaufmann classifies tumors of the stomach into six types:

(1) Bulky adenocarcinoma.
(2) Gelatinous carcinoma.
(3) Carcinoma following peptic ulcer.
(4) Carcinoma simplex; diffuse carcinoma.

(5) Diffuse scirrhous carcinoma.
(6) Sclerosing carcinoma.

Welsh, in reviewing 1,331 cases, gives the following classification: 791 or 64.8 per cent were medullary; 399 or 32.7 per cent scirrhous; 31 or 2.5 per cent colloid.

In our experience, bone metastasis following carcinoma of the stomach is very rare. In going through our records we were unable to find a case of gastric carcinoma accompanied by bone metastasis. In a review of the literature of the 41 cases showing bone metastasis following carcinoma of the gastrointestinal tract, 32 or 78 per cent followed carcinoma of the stomach.

Carcinoma of the small bowel is comparatively rare. In 3,000 complete gastrointestinal examinations, the essayist has recognized only 4 cases. Buel, in 3,563 malignancies of the intestines found only 89 or 2.5 per cent in the small bowel. Guser says 4 per cent of all carcinomata of the intestines occur in the duodenum. He reports 71 cases of carcinoma of the duodenum distributed as follows: 11 in the first portion, 51 in the second, and 9 in the third. The second portion, accordingly, is the favorite site. The lesions occur late in life, usually after sixty. Rolliston reports 35 cases of duodenal carcinoma. Eight were located in the first part, 24 in the second, and 3 in the third. Carcinoma of the jejunum and ileum is exceedingly rare. About 3 per cent of all carcinomata occur in the ileum and jejunum. The lesions usually occur early; 46.5 years is the average age, and the predilection increases near the stomach and large bowel. In none of the 42 reported cases showing bone metastasis was the primary malignancy located in the small bowel.

Carcinoma of the large bowel is comparatively common, especially in the later years of life. The incidence seems higher in the rectum and sigmoid than in the proximal colon. In the writer's experience, about 50 per cent of all malignancies of the large bowel occur in the rectum and sigmoid. The number of cases occurring at the flexures has been very small; only 4 have been recognized by the essayist. The Pathological Institute at Vienna, reports 343 autopsies showing carcinoma of the intestines from 1870 to 1893. The distribution was as follows: Colon 164; rectum 162; duodenum 7; ileum 10. Schleips, in his report of 596 autopsies of the intestinal tract, locates the malignancies as follows: colon, 259; rectum, 257; duodenum, 20; ileum, 60. Kaufmann reports 115 cases of carcinoma of the large bowel with the following distribution: colon, 36; sigmoid, 28; rectum, 51. He further states that 60 per cent of intestinal carcinomata are located in the rectum and that 5.25 per cent of all carcinomata are located in the rectum.

Karte, in 297 large-bowel malignancies reports 47 in the cecum, 22 in the ascending colon, 19 at the hepatic flexure, 44 in the transverse colon, 31 at the splenic flexure, 10 in the descending colon and 124 in the sigmoid. Although cancer of the large bowel usually occurs in the late years of life, cases have been reported as early as three years of age by Clar. Nothnagel reports a case of carcinoma of the colon at the age of twelve, and Garrard, a carcinoma of the sigmoid at the age of twelve.

In 4 of the 5 cases of the essayist's series, the carcinomata were located in the large bowel, namely, cecum, 2; sigmoid, 1; rectum, 1. The ages ranged from fifty to sixty; 2 were males and 2 females. The 4 cases were of low grade, slow growing types with late metastasis. The bone metastasis occurred about two years after the original diagnosis, confirmed at biopsy.

In our experience there has been a preponderance of metastases into the vertebrae, which is in accord with the cases reported in the literature. In 3 of the large-bowel malignancies we have noted changes in the vertebrae. The proximal third of the femur also seems to be a favorite seat of metastasis. All 4 cases showed definite lesions in the femora.

The osteoclastic type of metastasis has been the more common; in 3 of the cases the lesions were definitely destructive, while in 1 they were of the osteoblastic type. The patient showing the osteoblastic type of metastasis had a primary carcinoma of the cecum. The metastasis had the physical characteristics of the changes so often found following cancer of

the prostate. In fact, two very competent roentgenologists made such a diagnosis. The changes were quite extensive. The left humerus, left scapula, ischii and pubis were involved. During the month of October, 1922, a definite area of destruction occurred in the middle third of the left tibia, this being the only case to show metastasis below the knee (Fig. 1). The pain has been very severe in all cases, and morphine has been resorted to, to relieve

FIG. 1. Our only case which showed metastasis below the knee.

the suffering. The careful use of the roentgen ray does, in a large measure, control the pain, temporarily at least.

In some of the osteoclastic type cases after roentgen therapy, the lesions take on the physical characteristics of the osteoblastic type. The bones may become very dense and have the appearance of an osteosclerosis. Whether this is a favorable change, I am not prepared to say. The patient's general condition shows no great improvement, and the pain still persists. It seems reasonable to assume, however, that the process is influenced by the rays. The malignant cells are inhibited, at least, and in turn the osteoblasts may be stimulated and form new bone. The transformation or histological change may at least produce an extension of life, as the osteoblastic type does not progress so rapidly as the osteoclastic type. The above statement is only tentative as the series of cases is too small to draw any definite conclusions. We can say, however, that the case showing the osteoblastic type of metastasis survived the patients with osteoclastic changes.

CASE II. Male, white, was first seen on April 23, 1919, complaining of nocturnal epigastric distress. The distress had been present for the past year and was particularly severe about 2 A. M. At no time during the year had he experienced any nausea or vomiting. The distress had no relation to the taking of food and there had been no appreciable loss of weight. The bowels had been quite regular, as a rule, one movement a day. Some months previous, the patient had noticed the stools were of a tarry color.

Past History. The patient's father died at the age of seventy-two. The cause of death was said to be sarcoma. The mother died at the age of fifty-eight, cause unknown. Patient gave no history of venereal infection. Eight years ago patient had his appendix removed, and three years ago a hemorrhoidectomy. No other facts of importance were ascertained.

Physical Examination. The head and neck showed nothing of importance. The lungs were emphysematous, but otherwise normal. The apex of the heart was located 1 in. to the left of the nipple line. A systolic murmur was heard all over the precordium. The blood pressure measured systolic 125, and diastolic 73. The liver was 3 in. below the costal margin and was quite firm, but not tender on palpation. The spleen could not be palpated. There was marked tenderness over the epigastrium and colon. The prostate was slightly enlarged but no nodules could be felt and no tenderness was elicited. The urine showed a slight trace of albumen with a few hyaline casts. The stools showed no occult blood. The stomach analysis showed no free acid, either with Ewald or motor meals. The blood picture was as follows:

Reds, 4,000,500; whites, 9,900; hemoglobin, 72 per cent.

The roentgen-ray examination of the gastrointestinal tract, at this time showed no evidence of a lesion. The patient improved clinically for a time under diet and medical management. Eight months later, the hemorrhoids began to bleed. In December, 1919, on proctoscopic examination a polyp was found and later removed. The histological report was as follows: The microscopic structure of a polyp is present in the tissue. The surface epithelium is columnar epithelium of the mucous cell type. While there is no infiltrating growth in the tissues, these tumors are regarded as mildly malignant and tend to recur. Diagnosis: Rectal polyp; carcinoma.

On January 19, 1920, a barium enema revealed the following: the colon fills readily showing no filling defects in the rectum, sigmoid, distal or transverse portions. The distal colon is very spastic especially in its proximal half. The flexures are normal in outline and position. The transverse and ascending colons are normal in outline and position. The upper half of the cecum fills very readily and seems quite normal. The tip of the cecum fills with great difficulty and is definitely irregular in outline. The filling defect was very definite, but it was thought advisable to re-examine the patient two days later, to rule out any chance of the defect being due to fecal matter. The examination showed the filling defect still present. The following diagnosis was made: Filling defect involving the tip of the cecum which is probably due to a malignancy.

The first week in February, 1920, the patient was operated on by Dr. L. L. McArthur. The entire cecum was removed with about 3 in. of the terminal ileum, and the ileum was anastamosed to the hepatic flexure. At the time of the operation no evidence of any glandular involvement was found. The pathological report was as follows: Carcinoma of the cecum. Material: The specimen is the cecum of the large bowel extending upward a distance of 4.5 cm. There is also the terminal 7.5 cm. of the small bowel. The appendix has been removed. Immediately above the scar of the appendix is a cauliflower growth about 6 cm. in diameter which fills the cecum and extends into the ileocecal valve. In places the tissue is very indurated. Histology: Sections of the tumor contain infiltrating islands of tubular epithelium. In places these are circumscribed and their lumina contain mucoid material. No carcinoma was found in the sections of the lymph glandular tissue removed.

For two years following the operation the patient's general health was very good. In January, 1922, the patient returned to the hospital complaining of severe pain in

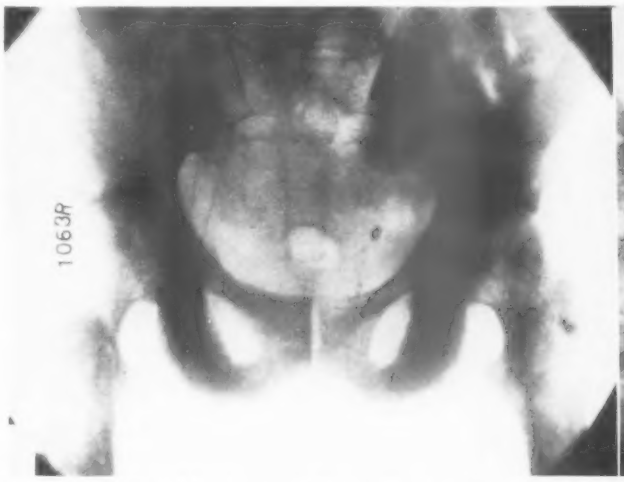

FIG. 2. Osteoblastic type of metastatic malignancy in pubis and ischium.

FIG. 3. Same case as Figure 2. Metastatic carcinoma of the shoulder.

SYNOPTICAL TABLE OF CASES OF CANCER OF THE INTESTINAL TRACT WITH BONE METASTASIS FOUND IN THE LITERATURE

Case No.	Reported by	Reference	Age	Sex	Site of Primary Cancer	If bone pains observed	If fracture of bone	Metastasis	Remarks
1	Sailer & Taylor	Internat. Med. Mag., 1897, vi, 404.	45	M	Stomach Ca. very small	.....	.....	Pancreas, glands and bone marrow.	Lowest red blood corp. 1,000,000. 9% myelocytes.
2	Otto Frese	Deut. Arch. f. Klin. Med., 1900, lxviii, 387–404.	28	F	Stomach carcinoma	Yes	No	Lungs, liver, pleura glands, sternum, vertebrae, ribs, femur.	Lowest R. B. C. 681,000 8% myelocytes. Spleen enlarged.
3	Ibid	Ibid.	26	M	Stomach	Yes	No	Lungs, brain, glands, ribs, vertebrae, skull, pelvis.	Lowest R. B. C. 800,000. No myelocytes. Spleen unchanged.
4	Kurpjuweit	Ibid, 1903, lxxvii, 553–578.	34	F	Stomach epithelioma	Yes	No	Liver, pancreas, glands, vertebrae.	Lowest R. B. C. 718,000 11% myelocytes. Spleen enlarged.
5	Ibid	Ibid.	42	M	Stomach carcinoma	.....	No	Liver, glands, vertebrae.	Lowest R. B. C. 4,320,000 4% myelocytes.
6	Ibid	Ibid.	51	F	Bile ducts carcinoma	Yes	Yes	Glands, ovaries, thyroid pleura, kidney, adrenallines, ribs, vertebrae, sacrum, sternum.	Lowest R. B. C. 3,200,000 17% myelocytes. Spleen enlarged.
7	J. Arneth	Zeitschr. f. Klin. Med., 1904, liv, 238.	25	M	Stomach scirrhous cancer	.....	.....	Lungs, liver, spleen glands, vertebrae sternum.	Lowest R. B. C. 1,072,000 7% myelocytes.
8	M. Zade	Beitr. z. path. Anat., 1904, xxxvii, 568.	33	M	Stomach carcinoma	Yes	.....	Skull, vertebrae, ribs, sternum, clavicle, and abdomen.	Lowest R. B. C. 2,944,000 40% myelocytes. Showed bilateral pupillary stasis.
9	Schleip	Zeitschr. f. Klin. Med., 1904, lix, 261.	34	M	Appendix colloid cancer	Yes	.....	Glands, mesentery, vertebrae, sternum.	Lowest R. B. C. 4,452,000 7% myelocytes. Spleen enlarged.
10	Ibid	Ibid.	33	M	Stomach epithelioma (latent and very limited)	Yes	.....	Vertebrae, ribs, pelvis, skull.	Lowest R. B. C. 1,084,000 7% myelocytes. Spleen not enlarged.
11	Goetsch	Beitr. z. path. Anat., 1906, xxxix, 218.	47	M	Rectum carcinoma	Yes	No	Glands, liver, kidney, lungs, sternum, skull, right femur.	Adenomatous metastasis.
12	Ibid	Ibid.	63	F	Gall-bladder carcinoma	.....	.....	Liver, pancreas, skin, mesentery, omentum, glands, skeletal system (skull vertebrae R. femur, ribs).	
13	Ibid	Ibid.	62	F	Gall-bladder carcinoma	.....	.....	Glands and vertebrae bodies.	
14	Naegeli	Quoted by Stempetinum in Med. Klin. Berl., 1908, iv, 704.	45	M	Stomach carcinoma	Yes	No	Liver, vertebrae, sternum.	Lowest R. B. C. 2,168,000 8% myelocytes. Spleen not enlarged.
15	Wolfer	Ibid.	37	M	Stomach carcinoma	.....	.....	Liver, lungs, pancreas, femur vertebrae.	Lowest R. B. C. 1,550,000 4% myelocytes.
16	Luzzato	Acc. Med. di Parma Feb. 28, 1908 and quoted by Harrington & Teacher.	45	M	Stomach cancer	.....	.....	Carcinomatous nodules in various parts of the bone marrow of the vertebrae.	Grave anemia. Myeloid reaction of blood. Original report not available.

17	Parmentier & Chabrol	Bull et. Mem. Soc. Med. d. hop. Paris, 1909, xxviii, 341.	45	M	Stomach scirrhous cancer	Yes	No	Glands, femur, marrow.	Lowest R. B. C. 1,040,000 8.6% myelocytes. Hb. 60% spleen enlarged.
18	Perls	Allg. Pathol. II, Aulf., p. 332.			Stomach fibrous carcinoma	Yes	.....	Glands, pancreas, lungs, lumbar vertebrae and 5th rib.	Epithelial structure in metastasis.
19	Harrington & Teacher	Glasgow Med. Jour., 1915, lxxxiii, 115.	59	F	Stomach carcinoma	Yes	No	Glands, ribs, right femur, left humerus.	
20	Harrington & Teacher	Glasgow Med. Jour., 1910, lxxiii, 241.	64	F	Stomach scirrhous cancer	Yes	Yes	Glands, omentum, ribs, femora, humerus, kidney, pancreas.	Lowest R. B. C. 1,600,000 5% myelocytes.
21	Harrington & Kennedy	Lancet, London, 1913, i. 379.	52	M	Stomach scirrhous cancer	Yes	No	Glands, sternum, ribs, and femora.	Lowest R. B. C. 2,325,000 3.8% myelocytes.
22	Parkes Weber	Quoted by Ward in Proc. Roy. Soc. of Med., 1913–1914, Med. Sec., p. 141.	32	F	Stomach carcinoma	No	No	Liver, suprarenals, glands, humerus ovaries.	Lowest R. B. C. 1,056,000 11.4% myelocytes. Spleen not enlarged.
23	Middleton	Glasgow Med. Jour., 1913, lxxxiii, 274.	49	M	Stomach adeno-carcinoma			Sternum, ribs, right femur, vertebrae, suprarenals.	
24	Jack & Teacher	Glasgow Med. Jour. 1918, lxxxix, 81.	58	M	Stomach carcinoma	Yes	Yes	Sternum, manubrium, ribs, left femur, vertebrae.	Lowest R. B. C. 3,390,000
25	Helmrich	Deut. Med. Wchnschr.	33	M	Stomach carcinoma	Yes	No	Vertebrae, sacrum, cranial.	Lowest R. B. C. 2,500,000.
26 to 33	Deelman	Nederland Tyssch v, Geneesk, 1921, ii, 1048 (8 cases).	Not	Stated	Stomach carcinoma	.....	.....	Bone metastases were vertebral; majority of cases and associated with visceral metastasis.	37 cases of bone metastasis were found in 528 autopsies of cancer patients.
34	.....	(1 case).	..	..	Colon carcinoma	.....	.....	With metastasis in vertebrae and sternum.	
35	.....	(1 case).	..	..	Pancreas carcinoma	.....	.....	Metastasis in vertebrae.	
36	.....	(1 case).	..	..	Rectum carcinoma	.....	.....	Vertebral metastases.	
37	.....	(1 case). "	..	..	Gall-bladder carcinoma	.....	.....	Vertebral metastases.	
38	Rohrer	Ewing Neoplastic diseases.	..	..	Stomach carcinoma	.....	Yes	Femur metastases.	
39	Panatelli & Carvaillon	Progres. Med., Apr. 14, 1906.	..	..	Stomach carcinoma	.....	.....	Cranial bones.	
40	Panatelli & Carvaillon	Progres. Med., Apr. 14, 1906.	..	..	Stomach carcinoma	.....	.....	Cranial bones.	
41	Tilling	1899 Osler.	..	..	Stomach carcinoma	.....	.....	Humerus.	
42	Jenkinson	1923.	60	M	Esophagus carcinoma	Yes	No	Lumbar spine.	
43	Jenkinson	1923.	62	M	Cecum carcinoma	Yes	No	Scapula, Ischium.	White count 2,300. Mass in abdomen. Lung metastasis.
44	Jenkinson	1923.	47	F	Sigmoid carcinoma	Yes	No	Femur.	Ascites. Complete obstruction. Severe pains in bones.
45	Jenkinson	1923.	64	F	Rectal carcinoma	Yes	No	Ribs, spine.	Semi-comatose condition for two months.
46	Jenkinson	1923.	60	F	Cecum carcinoma	Yes	No	Ribs, spine.	Severe pain in spine.

the pelvis and thighs. Roentgen examination at this time showed what was thought to be an osteoblastic type of malignancy in the pubis and ischii (Fig. 2). Roentgen therapy was immediately instituted and continued at frequent intervals, until January, 1923. The treatment seemed to control the pain, and for a number of months his condition was such that he could carry on his business. During March, pain developed in the left shoulder, which, on roentgen examination was found to be due to a metastatic carcinoma (Fig. 3). In October the patient's condition became decidedly worse and he was obliged to remain in bed. In spite of heavy roentgen therapy the pain persisted, and seemed to travel from one place to another. About the time the pain in the shoulder was under control, the pain in the pelvis and femora would become acute. During the month of January, 1923, a large mass developed in the abdomen, and the lungs showed what was thought to be secondary carcinomata. The patient's condition became progressively worse, and during the first week in April, 1923, he succumbed. An autopsy was not obtained.

Case III. Male, white, entered the hospital June 28, 1922, complaining of pain in the back.

In July, 1921, the patient was operated at Mayo Clinic for carcinoma of the rectum, at which time a colostomy on the left side was done. Since the colostomy the bowel movements have been very sluggish. The first of February, 1922, severe pain in the back developed, which extended down the right thigh and leg. On April 29, 1922, the patient was operated for an acute appendix. At this time the peritoneal cavity contained many enlarged glands which on section were carcinomatous.

The patient entered the hospital primarily for roentgen therapy. Films taken at this time showed no evidence of metastasis in the lumbar or dorsal spine or in the femora.

Roentgen-ray treatment was started and was distributed over a period of ten days. The pains down the legs improved for a time, but the improvement was only temporary, and in two weeks the pain was again very severe. For two weeks following the treatment a severe diarrhea developed and blood was found in the stool. The patient's condition became progressively worse, and the frequent use of morphine was necessary to control the pain. Food was refused, and the patient became delirious. For the next two months the patient remained in a semi-comatose condition, and on October 30, 1922, succumbed. The autopsy showed extensive metastases into the lungs, liver and spine, with a primary carcinoma of the rectum.

Case IV. Female, white, aged forty-seven, entered the hospital November 9, 1921, complaining of swelling and pain in the abdomen. The pain was especially well marked in the right lower quadrant and down the right thigh. Previous to June, 1921, she had enjoyed very good health; at this time an uncontrollable diarrhea developed which continued through the summer. During this time the patient went to stool twelve times daily. The bowel movements were watery and reddish in color. The swelling of the abdomen became more pronounced and the pain was very severe on turning from side to side. There seemed to be no pain on the taking of food. Frequent urination was complained of, and for the past six weeks she had suffered from a severe cystitis. The past history regarding the diseases of childhood was negative.

Family History. Mother died at the age of fifty-six from epilepsy; father died at the age of seventy of cancer; three sisters living and well; one brother aged sixty, living and well; one brother died at the age of fifty-six. There was no history of tuberculosis in the family.

Menstruation began at the age of fourteen, regular until 1918. Married twice, never pregnant.

Physical Examination. The head, neck, heart and lungs are negative. The abdomen is large and tense, contains fluid and is very tender on palpation. The size corresponds to about a seven months' pregnancy. In the lower right quadrant there is a mass about the size of an orange which is very tender on palpation.

On November 11, 1921, the abdomen was opened and a large cyst of the ovary

removed. A month following, the patient was sent home. The pain, however, was still present. While at home, the abdomen became larger, and on January 31, 1922, she returned to the hospital suffering from an acute obstruction of the larger bowel, probably the sigmoid. The patient had taken very little food, and suffered a great deal from vomiting. Roentgen-ray examination at this time showed an absolute obstruction at the junction of the sigmoid and pelvic colon. The lumen of the bowel was very irregular, and a diagnosis of a malignancy was made. On February 4, 1922, the abdomen was opened by Dr. Fred Besley, and a large mass involving the sigmoid was found, which proved to be a cancer. The distal colon was brought up, and a colostomy performed. The colostomy relieved the obstruction, but the pain in the abdomen and down the thigh still persisted. The pain grew progressively worse and large doses of morphine were given. Very severe pain developed in the upper third of the femur. The roentgen-ray examination of the femur showed definite mottled areas in the neck and upper third, which had the appearance of metastatic carcinoma (Fig. 4). The femur was examined from time to time, and the process rapidly progressed. The roentgen-ray reductions show the progress very clearly (Fig. 5).

During the last six months of the patient's life, seven to eight grains of morphine were necessary to relieve the pain. On February 19, 1923, the patient died. No post mortem was obtained.

FIG. 4. Case IV. Metastatic carcinoma of the neck and upper third of the shaft of the femur.

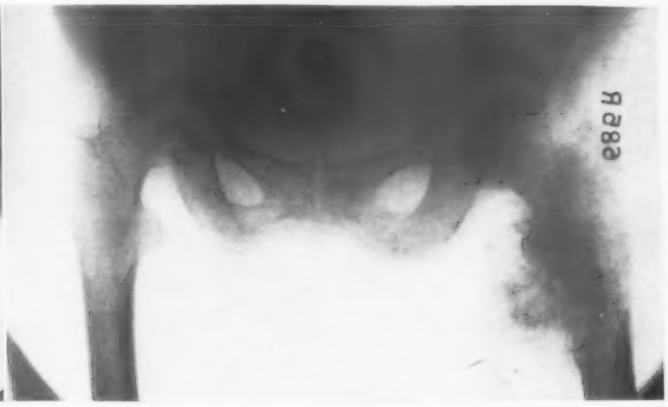

FIG. 5. Case IV. Taken at a later date than Figure 4.

DISCUSSION

DR A. B. MOORE, Rochester, Minn. The diagnosis of metastasis has proven a question of considerable difficulty, in my experience. I have met with considerable difficulty in differentiating the osteoplastic type from Paget's disease of the bone. I would like to ask Dr. Jenkinson if he has any distinctive points in the differentiation.

Since the advent of the grid I will say without hesitation that I think we have been able to obtain more satisfactory examinations. The perplexing thing to me in the osteoplastic type of metastasis is the atrophy from non-use that you get in people that have been hospitalized for a long period. The osteoporosis that we see there makes it very difficult always to establish the diagnosis of bone metastasis. I would like to ask Dr. Jenkinson whether he has ecountered this.

DR. S. CLARK, South Bend, Ind. I would like to report 1 case that Dr. Moore's remarks called to mind. A man thirty-eight years of age, a farmer, was working about his yard and standing on an ordinary saw horse about 2 ft. high; the saw horse tipped over and the man stepped down onto his feet. At the time he had a little discomfort, but went about his affairs. The next morning he had pain in the lower lumbar region which gradually grew worse with flexion of the right leg. The flexion increased and later he consulted a chiropractor, who treated him for some weeks, three weeks, I believe. He then came in to

our office for a roentgen examination. We found what we believed to be a fracture of the fifth lumbar vertebra; there was also evidence of an osteoclastic process. The man was advised to be hospitalized and placed in bed for the treatment of this fracture. Almost immediately he began to vomit and have stomach symptoms. The history then developed that the man had had slight symptoms of indigestion during the previous year, but nothing that interfered seriously with his health. Following the development of the vomiting a roentgenographic examination was made of the gastrointestinal tract, which revealed what we believed to be an extensive carcinoma of the upper two-thirds of the stomach. There was no interference with the emptying time of the stomach, and no involvement of the pylorus. An exploratory operation was made, and an extensive mass was found in the stomach, microscopical sections of which proved it to be a carcinoma. The man had a negative Wassermann. He died two weeks after the exploratory operation from continued vomiting and exhaustion. There was no microscopical examination made of the vertebrae, but in the light of the history and from the roentgen appearance of this vertebra, we believed it to be a metastatic carcinoma of the fifth lumbar vertebra.

The interesting feature was that the man had no stomach symptoms whatever until after he had had the fracture of the vertebra.

DR. JENKINSON, closing. Attempting to answer Dr. Moore's question regarding Paget's disease, I will say that in the few cases we have seen the pathology occurs in the tibiae and the skull. The patient is usually about forty-seven years of age.

The changes in both the tibiae and the skull are, I believe, quite characteristic, and should not be confused with metastatic carcinoma of the bones.

Instead of a breaking down and osteoplastic changes, there is more apt to be a great deal of new bone-formation. This is especially true of the vault of the cranium.

In the cases we are reporting, the microscopical findings showed definite carcinoma involving the cecum and sigmoid. The microscopical findings, I believe, make the diagnosis positive.

EVENTRATION OF THE DIAPHRAGM*

BY HENRY J. WALTON, M.D.

BALTIMORE, MARYLAND

THE condition known as eventration of the diaphragm was first described by J. L. Petit in 1774, but it was not until 1829 that Cruveilhier used the word "eventration" in differentiating this unusual malformation from hernia of the diaphragm. Although the term is misleading, it has now been generally adopted and represents a condition in which one dome of the diaphragm is stretched out and elevated high into the thoracic cavity so that the abdominal viscera immediately beneath are contained within the thorax; while in diaphragmatic hernia, the abdominal viscera are displaced into the thoracic cavity through a normal or pathological orifice in the diaphragm.

Eventration of the diaphragm does not necessarily produce symptoms. When these do occur, they are usually referred either to the cardio-pulmonary, or digestive organs. It is found four times more frequently in men than in women. Most observers believe it to be of congenital origin, which is substantiated by the fact that it has been found in a number of infants, and is usually associated with other congenital defects. It nearly always involves the left side of the diaphragm, the top of the dome often reaching as high as the second or third interspace anteriorly. The viscera in ectopia are usually the stomach, colon, small intestines, liver, spleen and kidney. Only 6 cases of eventration on the right side have ever been reported. When it does occur on the right side, there are no gastro-colonic or cardiac signs, the liver being the organ which fills up the abdominal projection.

Eventration was formerly an autopsy discovery just as it is now a roentgenographic discovery. It is mainly on account of the value of the roentgen ray in making the diagnosis of eventration of the diaphragm, that this subject is being presented, and my remarks will be confined chiefly

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to a consideration of the roentgenographic signs which make it possible of differentiation from other conditions.

The first case diagnosed during the life of the patient, was reported by Glaser in 1901; this patient was supposed to have had a diaphragmatic hernia, but at operation, eventration was found. The patient recovered.

The first account that I have been able to find of the use of the roentgen ray in the diagnosis of this condition, was in 1900 when Hirsch diagnosed a case as hernia of the diaphragm. In 1901 Struppler reported a case of hernia of the diaphragm based on roentgen findings. Both of these cases, however, proved subsequently to be eventration. Considering the difficulty experienced even now with all modern methods of diagnosis in differentiating eventration and hernia, due credit should be given to these men in spite of their misinterpretations.

Bergmann in 1913 in his excellent review of the literature of eventration of the diaphragm found reports of only 22 certain cases and 5 probable cases of eventration; several of these were diagnosed by means of the roentgen ray. During the past ten years there have been more authentic cases of eventration reported than in the previous one hundred and thirty-nine years, when Petit reported the first case in 1774. Nearly all recent writers mention the roentgen ray as an aid in arriving at the correct diagnosis.

In the differential diagnosis, the most common conditions which give similar roentgen shadows, are pleural effusion, pneumothorax and hernia of the diaphragm. The two former can very readily be eliminated by the use of the barium meal and enema. If the stomach or colon is located in the thorax, the only quesion to decide is whether they are above or below the diaphragm, hence the diagnosis narrows itself down to a question of eventration and hernia.

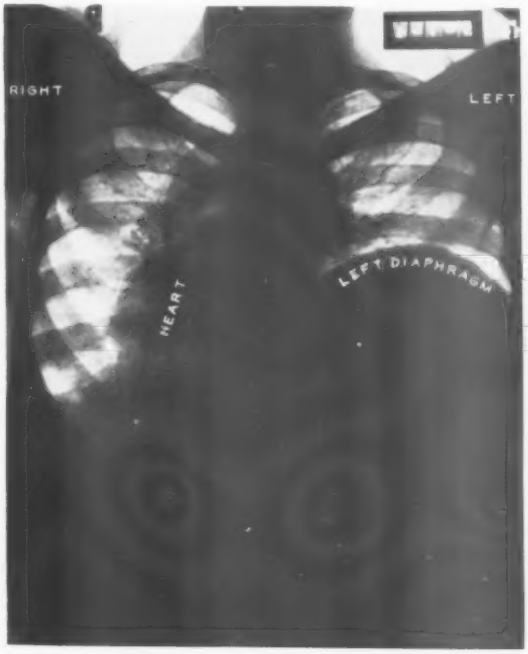

FIG. 1.

FIG. 2.

Quite a number of roentgenographic signs and observations have been brought forward by various writers in recent years, but only those which seem most important, and which should always be looked for will be mentioned, namely:

(1) The high position of the diaphragmatic arch.

(2) The regular contour of the arched line.

(3) Excursion usually present, but limited.

(4) Paradoxical movements on the affected side.

(5) Mediastinal excursion, from the affected side toward the sound side during inspiration.

(6) Displacement of the heart to the right.

(7) Distinguishing line between the diaphragm and viscera below.

(8) Pneumoperitoneum.

In eventration there is always present the typical curved line of the dome of the diaphragm, which lies high in the thoracic

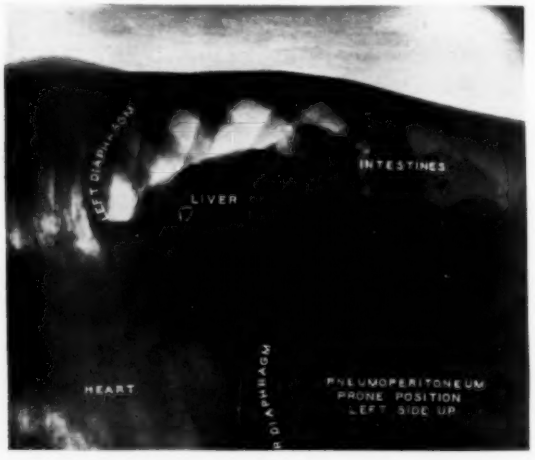

FIG. 3.

cavity, but this is not sufficient for diagnosis as the same condition is sometimes seen in hernia, where a dilated stomach or colon gives a similar appearance. In hernia the contour of the arch is usually irregular and somewhat nodular.

In eventration respiratory excursion is nearly always present, but the movements are limited on the affected side. Paradoxical movements (inspiratory ascent and expiratory descent) of the affected side of the diaphragm have been observed in eventration, but this condition has been noted more often in hernia. Mediastinal excursion to the right side during inspiration, due to a greater degree of intrapleural pressure on the sound side, is a sign which has been observed and should be looked for, although its value in differentiating eventration from other abnormal conditions of the left side of the thorax is questionable.

The only pathognomonic roentgen sign of eventration of the diaphragm is a distinguishable separation of the arched line of the dome of the diaphragm from the viscera below. This can best be accomplished by the introduction of air into the peritoneal cavity. The patient may be examined in either the upright or lateral position. In eventration the abdominal viscera will drop away from the diaphragm, while in hernia the dome of the diaphragm cannot be isolated from the hernia above. It is only necessary to introduce a small amount of air in order to make this test. In cases of hernia, care must be exercised not to overdistend the abdomen on account of the danger of producing a strangulation. If fluid is present in the abdominal cavity, this should be withdrawn before the introduction of air.

CASE REPORT

The patient, a colored laborer, aged forty-nine, entered the University Hospital September 1, 1923, complaining of gastric symptoms.

Family History. Negative.

Past History. Unimportant, except he stated that he had a chancre twenty years ago, for which he was treated and cured. No evidence of secondary lesions. Patient stated he was told fifteen years ago that his heart was on the right side.

Present illness began eighteen months ago when he first noticed swelling of his feet and ankles. The legs, thighs, scrotum, and abdomen gradually became involved. Ascites became so great that a paracentesis was performed and three quarts of a clear, straw-colored fluid were withdrawn, after which the patient's condition improved and he went back to work. Several months elapsed before the edema reappeared and with it abdominal symptoms returned, such as tightness and fullness after eating. He complained of no pain. His appetite remained good and there was very little loss of strength. He had been constipated for the past six months.

Physical examination showed an apparently undernourished man of medium stature, face slightly drawn, skin loose,

eye balls prominent; pupils equal and reacted to light and accommodation: teeth in poor condition; tongue dry and furrowed; thyroid not enlarged.

Chest asymmetrical, left side more prominent than the right. Respirations not embarrassed. Percussion showed impairment on the left side below the 4th rib anteriorly, and the 7th rib posteriorly. Below this area, breath sounds were not audible, but above they were loud, clear, and vesicular. Percussion of the cardiac area showed a vertical border on the left side 1¾ in. from the mid-sternal line, the right border taking a diagonal course, outward and downward, its most lateral point being in the 5th interspace at the nipple line. Cardiac area did not change position upon turning patient from side to side. The heart beat was quite distinct just below the right nipple, at which point a sharp impulse could be felt. Pulse regular; no palpitation.

The abdomen was distended, and was most prominent in the left hypochondriac region. The thoracico-epigastric veins were distended. The percussion note was tympanitic in the upper right abdomen. There was no palpable mass in the right hypochondriac region but a resisting mass was felt in the left hypochondrium.

Genito-urinary Tract. There was increased frequency of urination, no pain and no hematuria. The urine was dark in color, and there was a trace of albumin.

Blood examination, negative.

Wassermann, 100 per cent positive.

The deep reflexes were sluggish. There was no ankle clonus and no Babinski sign, and no sensory disturbances. Rhomberg negative. All coordination tests were good.

Roentgen examination showed a very high left side of the diaphragm, the top of the dome being on a level with the second interspace anteriorly. The diaphragm was freely movable. The left costophrenic angle was clear. The outline of the right side of the diaphragm was irregular. The costophrenic angle did not clear on deep inspiration and excursion of the right side was limited, due probably to adhesions following some old inflammatory process at the right base. There was evidence of considerable pleural thickening.

Both lung fields were clear. There was considerable increase in density in the root and bronchial shadows, especially on the right side. Several small calcified lymph nodes were present in the right root region.

The heart was transposed, its left border being about 1 in. to the left of the spine, its right border about 3 in. to the right of the spine. The mediastinal contents were also displaced to the right. The aorta was moderately dilated.

The opaque meal passed normally down the esophagus into a medium sized stomach, the esophagus being displaced slightly to the right. The cardiac end of the stomach was in the left hypochondrium, and the greater curvature on a level with the umbilicus. The pylorus was to the right of the second lumbar vertebra. The stomach and cap were normal in outline.

The roentgen examination after a pneumoperitoneum, following the withdrawal of fluid from the abdominal cavity, showed the left diaphragmatic arch in the same position as previously reported, with a large airspace between the diaphragm and the abdominal viscera. Below the air was seen a large dense mass simulating the liver, and superimposed on this shadow were two smaller and fainter shadows, one of which had the appearance of a kidney. The patient would not consent to a cystoscopic examination.

Immediately below the right side of the diaphragm were coils of intestines partially filled with air. No shadow of the liver or other mass was seen below the right side of the diaphragm.

The following is a summary of the roentgen signs present in this case:

(1) The high, smooth contour of the left dome of the diaphragm.
(2) Free excursion of the diaphragm.
(3) Transposition of the heart.
(4) Isolation of the arched line of the diaphragm after pneumoperitoneum.
(5) Associated congenital defect. (Transposition of liver.)

Signs not observed:

(1) Paradoxic movements.
(2) Excursion of mediastinum to right during inspiration.

Conclusions based upon the roentgen examination:

(1) Eventration of the left side of the diaphragm
(2) Dextrocardia
(3) Transposition of the liver

Eventration of the diaphragm has always been considered a rare condition and has seldom been discovered in life except by the aid of the roentgen ray. It is quite probable that its occurrence is far more frequent than has heretofore been supposed, and the possibility of its existence must always be borne in mind whenever the diaphragm is situated higher than normal, especially if this is accompanied by a displacement of the heart to the right.

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REPORT OF A CASE OF TRAUMATIC HERNIA OF THE DIAPHRAGM*

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A REVIEW of the literature of hernia of the diaphragm is hardly necessary for the purposes of this case report. There have been many cases reported since the advent of the roentgen ray and, considering the disparity of reports on this condition prior to 1913, it would appear that the clinical evidence was either insufficient, in a large proportion of cases, to call attention to the possibility of the existence of a hernia, or the clinician had not been sufficiently on the alert.

Giffin, in 1913, reported upwards of 690 cases recorded in the literature up to that time, but of all these cases only 15 had been diagnosed, the others having been found at necropsy.

Since then a large number of cases have been reported, but in many instances the findings were incident to a study of the gastrointestinal tract by the roentgenologist.

Although few conclusions can be drawn from 1 case, nevertheless the conditions surrounding 1 case may be sufficient to emphasize the necessity for eternal vigilance. Hence this report.

The patient, a male, aged forty-seven, occupation trucker, was admitted to the Surgical Service of the Frankford Hospital on September 16, 1921, following an automobile accident, in which he was squeezed between a building and the wheels of a truck. At that time he suffered a fracture of the left femur on a level with the lesser trochanter, and contusions of the left leg and abdomen. No symptoms referable to the chest or ribs were noted at this time, except that the patient complained of pain in the upper left quadrant of the abdomen. No request for chest or abdominal roentgenograms was made at this time. The previous history was irrelevant.

Nineteen days after admission the patient was transferred to the Municipal Hospital with scarlet fever.

On May 17, 1923, almost two years after the accident, the patient was referred to me by Dr. John Raftery, his family physician, to determine the presence of any pleuritic disturbances arising, possibly, from old fractured ribs at the time of the accident. The patient complained of indefinite pains in the chest and abdomen, mainly on the left side.

Roentgenograms were made, but no roentgenoscopic study was made at this time. The roentgenograms revealed a peculiar lack of outline of the normal diaphragmatic dome on the left side and a few rather heavy lines suggestive of pleuritic adhesions with some pulmonary thickening.

I requested the patient's return for examination by roentgenoscope and opaque meal, at which time we found a hernial opening of large caliber in the left diaphragm through which passed the stom-

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ach, portions of the small intestines and colon.

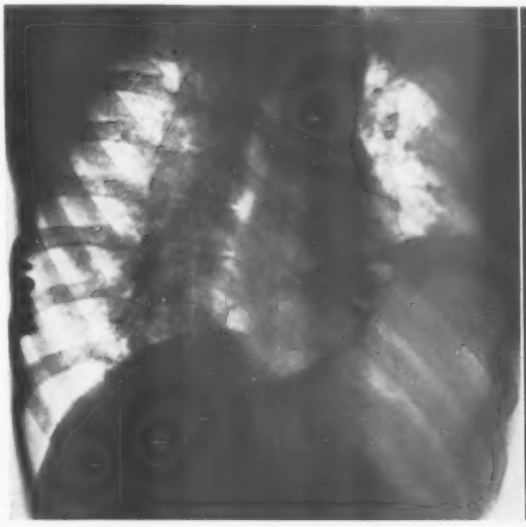

FIG. 1. P. A. Prone position showing pathology at left base with irregular double lines of diaphragm shadow.

FIG. 2. Oblique prone showing wide posterior gap in left diaphragm.

On May 27, ten days later, the patient was admitted to Frankford Hospital.

FIG. 3. P. A. Erect with barium-filled stomach.

FIG. 4. P. A. Prone with barium-filled stomach passing through rent in diaphragm.

The history states that since the accident two years previously, he had suffered more or less from pains in his left chest, with exacerbations in the last three weeks. He had dyspnea; there was some nausea, but no vomiting. He complained of a sense of epigastric fulness, and gurgling in the left chest with slight palpitation at times.

Physical Examination. The heart sounds were heard best near the sternal border on the left side, and faintly to the right of the sternum; not heard at all in the left nipple area. Gurgling sounds were heard in the normal heart area. The heart sounds were normal as to rhythm, etc.

FIG. 5. Injected colon passing through rent in diaphragm.

The lungs showed normal resonance on the right side. The left side presented a tympanitic area over the normal heart area with slight impairment at the base.

The abdomen was negative.

The day after admission the patient was operated upon. The following description of the operation and findings are given through the courtesy of Dr. C. F. Nassau and Dr. L. D. Englerth, the surgeons:

"The patient was anesthetized with intratracheal ether. An incision was made in the left chest and the pleural cavity was entered. Protruding through the diaphragm were found the stomach, omentum, portions of the small intestines and a portion of the colon. By means of packs, these organs were replaced in the abdomen and a rent of about 5 in. long was repaired. The tear passed from behind in the left crux of the diaphragm, forward and across. No sac was present. The edges were perfectly healed, the pleura and peritoneum being healed over the edges. A needle was placed in the left pleural cavity and the chest closed tightly. The suction apparatus was applied through the needle at the same time that extra positive pressure was made through the intratracheal apparatus, resulting in the almost complete return of the collapsed

FIG. 6. Postoperative erect with stomach in normal position. Some exudative pathology still present at left base.

FIG. 7. Postoperative. Prone with stomach retaining its normal position.

lung to a normal position, without a pneumothorax persisting."

The patient made an uneventful recovery and prior to discharge three weeks after admission was again roentgenographed. The diaphragm on the left side was functioning normally and presented a normal outline. The pleura was somewhat thickened and contained a small quantity of fluid but was otherwise negative.

In conclusion let me call attention to a few lessons this one case has taught me.

1. The possibility of the existence of a traumatic hernia without marked clinical evidence.

2. The necessity for the roentgenologist to carry his studies to a satisfactory conclusion, approaching every examination with an absolutely open mind, uninfluenced by history or clinical suggestions. If the diagnosis of diaphragmatic hernia, whether congenital or acquired, as well as many other conditions, is dependent on the roentgen ray, it behooves the roentgenologist to extend his field of usefulness by not limiting his examinations to too narrow or limited areas.

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PALLIATIVE DOSES OF ROENTGEN RAY IN ADVANCED CANCER*

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THE physical basis of deep roentgen therapy is firmly established, for not only can electric currents be induced to activate a roentgen-ray bulb to produce a radiation of wave-lengths approaching that of the gamma ray of radium, but the comparative effectiveness of these rays on the surface and in the depths has been determined by the spectrometers and the iontoquantimeters. The properties of filters are so well known that almost any desirable hardness of the primary beam can be obtained. The effects of scattered and secondary radiation on the depth dose quotient have been determined by actual measurements in phantoms of wax or water. From a mass of experimental data physicists in this country and abroad have plotted charts by which we can figure our doses as indicated in deep therapy.

From the clinical point of view the problem of the radio-therapy of neoplasms rests on far less certain grounds. We have as therapists no exact standards by which our effects can be predicated, calculated or measured. The only criterion by which we can judge any radiation we are using is by its biologic effect on the patient.

By clinical experience the biologic effects of hard and soft rays on the human body have been found out. We know fairly exactly at what point an erythema arises in the skin. We know where more violent or more destructive changes will be produced. We have a rough idea of the susceptibilities of the various normal tissues to radiation. But in the treatment of a patient with cancer we are confronted with a special individual problem. The better our knowledge of the pathologic anatomy of the patient's disease, and the more exact our control of the physical factors involved, the more scientifically exact will be our therapy.

The idea of intensive roentgen-ray dosimetry on the unit of the skin erythema dose was conceived by German roentgenologists (Seitz and Wintz, Krönig and Fried-

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rich). They have said that there is little individual variation in susceptibility of normal skin to roentgen ray—the limit of variation being set at 15 per cent—so that the amount of radiation needed to produce an erythema can be used as a standard, for obviously the limit of tolerance of skin is the limit of intensity by which a subcutaneous tumor can be radiated.

Our experience to date does not confirm the observation of others that a dose of roentgen ray which in one patient produces a mild erythema may in a second produce a severe reddening, and in a third vesication. We have found nothing that can be properly called an idiosyncracy to roentgen ray; nor can we fully agree that the erythema is definable in as narrow limits as others have determined it. We have observed our skin doses through a galvano-ionto-quantimeter in such a way that the output of the roentgen-ray tube during a treatment was constantly measured. These observations will be noted in another report.

In the same way that a skin unit dose has been set up there have been established by continental roentgenologists the so-called "cancer dose," "sarcoma dose," "castration dose," etc., all figured in percentage of an erythema. This conception certainly gives us a technique with which to begin our therapy, but whether or not these values have the fixity set for them there is at present no irrefutable evidence by which to decide.

Recently there have appeared in the literature accounts of damage to normal tissues by doses theoretically safe, indicating that there is a varying susceptibility of normal deep-seated tissues to doses under quite absolute physical control. The first damages noted were those to the blood. There have appeared a great number of reports on this subject. Fischer[1] cites some personal cases of intestinal damage by roentgen ray, and gives a critical review of the German literature to date. Some of the damages noted were caused by raying through a single port with a single erythema dose; others were due to errors of technique. The damage to the pleura and lung incident to the radiation of breast cancer was cited by Groover.[2] The possibility of producing destruction of the suprarenal in radiation of gastric cancer has been mentioned by Holfelder. The occurrence of rectal and bladder fistulas in the treatment of cancer of the cervix both by radium and roentgen ray is both well known and much feared. Late skin effects of *Super-roentgenization* have been described by Seitz.

If there is such a variation in susceptibility of normal tissues to radiation exterally applied as these few examples seem to indicate, it can logically be assumed that there is the same variation in the reactivity of neoplasms. The very nature of new growths seems to forestall any standardization of doses for tumors. Clinical observation has repeatedly shown that two tumors of the same histologic structure may exhibit an entirely different life history of malignancy. Certainly there remains no doubt about the different reactivity of epidermoid and adenocarcinoma to external radiation. Indications seem to point to the fact that adenocarcinomata originating in the breast, in the intestine and in the uterus are to be regarded as three distinct diseases. That adenocarcinoma, relatively a susceptible tumor, can be highly resistant under some conditions can be attested by three personal cases (breast) rayed with from three to five erythema doses through copper or aluminum in none of which did healing take place. One case of fungating epidermoid cancer, metastatic in the groin, was given seven erythema doses divided, through copper, with no marked improvement.

There seem to be no well-marked boundaries in the microscopic structure of tumors. One heterogeneous group of cell structures grades off into another. For this reason attempts to standardize tumor-doses on the susceptibility of some type-tumor have been unsuccessful. It seems, therefore, that the doses of roentgen ray necessary to destroy cancer, which is in itself a very varying entity in malignancy, are definable only in similarly wide limits.

[1] Fischer, Bernh. Uber Bestrahlungsnekrosen des Darmes. (Mitt 3 Abb). *Strahlentherapie*, 1922, xiii, 333.

[2] Groover, Thos. A. Intrathoracic changes following roentgen treatment of breast carcinoma. Am. J. Roentgenol., 1923, x, 471.

The uniform susceptibility of sarcoma to uniform doses of roentgen ray stands on just as uncertain a foundation. The possibilities for variation in sarcoma structure and malignancy—even though there is no definite fixed relation between them—seem as great as in the cases of epithelial tumors, so that sarcomas, too, may exhibit widely varying biologic phenomena. Sarcoma, as is well known, manifests itself as widely varying clinical entities. Here also it would seem that the dose depends on the possibilities of combination of histologic structure, on the stage of development of the tumor, as well as on the little understood tumor host himself.

In their collected report, Werner and Grode[1] emphasize particularly that the capability of reaction of tumor structure to radiation shows great variation, and that carcinoma and sarcoma doses represent only the minimal values. The same view is held by other German roentgenologists, among whom may be mentioned Holtzknecht, Holfelder, Eckelt, and others. Strauss[2] insists that the conception of uniform susceptibility of cancer to radiation is untenable. The same view has for years been held in this country by Wood and by Ewing, most effectively expressed by the latter in the Mutter Lecture "An Analysis of Radiation Therapy in Cancer."

The peculiarly great susceptibility of embryonal tumors to radiation has long been established. Tumors of poorly differentiated, rapidly growing cells, rich in blood vessels, have for years been one of the most satisfactory fields of radiotherapy. As a rule tumors of lymphatic origin are also favorably influenced. Yet some microscopically undifferentiated tumors (teratomas, for example) may show a marked resistance to radiation, while others of a more adult structure may show a great susceptibility. Similarly, not all lymphosarcomas do well under radiation. Yet it does not seem that differences in makeup alone of tumors account for the differences in their radiosensitiveness.

It seems fairly well demonstrated clinically that there is no uniform destructive dose of roentgen ray for all cancer cells. That the effect we want to get is a direct destructive, killing action on cancer cells alone has been contested by many observers. That a homogeneous killing dose is the desideratum is denied on many sides. But assuming that these are the optimum criteria, there is at present no agreement whether this dose shall be given best in one or in several sittings, or, if a repetition is indicated, after what interval it should be given.

There are many recent statistics which show that with increased intensity of radiation an increased percentage of recurrence is noted. Werner, on a basis of his observation of 8000 cases of malignant disease treated at the Heidelberger Krebsinstitut, warns against treating tumors too vigorously, and especially with hard rays.

Arguments for and against single intensive doses are manifold.

Opitz,[3] in a careful survey of cases treated by Perthes, Ansschutz, Krönig and himself, made the observation that the best curative results were obtained by repeated radiation in which the socalled "cancer dose" of deep therapy was not obtained. Certainly there remains no doubt that proven cancer has been repeatedly cured by roentgen-ray doses of far less intensity (9-in. spark gaps, for example) than those now in vogue in deep therapy.

Halberstadter, Blumenthals, Theilhaber, M. Fraenkel, Caspari, Ribbert and others have suspected that the results of radiation do not depend on an actual destruction of cancer cells, but on the strengthening and stimulation of the normal surrounding structures in addition, in such a way that the cancer cells are conquered and their proliferation prevented. Ewing (loc. cit.) says, "From the study of much material from operation and autopsy in cases treated by deep radiation I have become convinced that the clinical results are not usually due to the direct killing action of the radiation, but are brought about indirectly, and mainly by interference with the circulation, capillary, venous, arterial and lymphatic. This conclusion is in accordance with the rule of pathology

[1] Werner and Grode. *Ergebn. d. Chir. u. Orthop.*, Oct., 1921, xiv, 222.

[2] Strauss, O. Modern cancer treatment. *Deut. Med. Wchnschr.*, 1921, xlvii, 597.

[3] Opitz, E. Principles of radio therapy of carcinomata, especially of uterine and mammary carcinoma. Am. J. Roentgenol., 1923, x, 312.

that acute necrosis of tissue cells generally means interference with the blood supply. . . . On the other hand when one proceeds in deep therapy on the theory that therapeutic results depend not only on injury to tumor cells but also on defense reactions of the body and the tissues, the immediate results seen seem to be most equally striking, and the end-results often more satisfactory, and the treatment is conducted with less damage and danger to the patient."

It would be ideal to find a radiation dose fatal to each case of tumor which could exert on the surrounding normal cells a stimulating effect, but unfortunately the cells of the various tissues have not this degree of differentiation of susceptibility, and the conception of such a dose must for the time being remain an ideal. The margin of safety between damage to tumor cells and to normal cells is in reality an extremely narrow one.

Many observers have called attention to the clinical fact that patients with advanced cancer do poorly under any form of therapy. The primary breast tumor, with wide-spread metastases, has in our experience as in that of others, manifested a peculiar hyper resistance to roentgen-ray doses while in cases of the same type of tumor with less involvement satisfactory regression has been produced. It may be that in this type of disease the tumor has taken on new growth characteristics of such a type that its biologic reactivity to radiation is different, or it may be that the resistance or immunity of the host to tumor invasion is decreased. At present both views are without absolute confirmation.

Similarly, most roentgenologists agree that cachectic patients are extremely poor subjects for radiation therapy. Not only are they not able to stand a cycle of intensive treatment, but they are regarded as approaching the natural fatal termination of their disease. Their reserve of bodily functional capacity is at a low ebb; their power of healing and regeneration is very slight. To decrease their nutrition by postradiation nausea, to produce hemorrhage into the tumor, to destroy their blood elements, to add to their pain, or to add to the toxic effect already present, will hasten the approaching end.

This advanced, cachectic, hopeless group of primary and recurrent cancer is the basis of this report. All—100 per cent—were inoperable. All were poor risks for any form of intensive or radical therapy. Nothing approaching a cure could be hoped for in any case.

In the following case history reports we are frank to admit that we have selected favorable cases. But here we are dealing with a vague term, especially since the prognosis of every patient is so bad. We are not citing a group of cases large enough to enable us to draw any conclusions. No result has stood the test of the accepted four year interval. The doses used are mentioned only as an indication of what may be accomplished, and are not advanced as a technique to follow in earlier and more favorable cases.

CASE REPORTS

CASE I. Male, aged forty-seven. Attention first directed to trouble in antrum in February, 1923, when a molar tooth became loose. Patient had various kinds of treatment—no surgery nor radiation until June when he received both radium and roentgen ray at another hospital, the last treatment being in September. Biopsy was made which showed round-cell sarcoma.

On October, 15, 1923, he was admitted to this hospital, with severe pain in left face and very poor general condition. Examination showed marked prominence of the left eye with complete obliteration of the infra-orbital hollow and marked reddish blue discoloration of the whole region. Patient could not close his left eye. The antrum was protuberant and the left nares blocked.

Roentgen examination showed considerable destruction of the malar bone and a marked haziness about the frontal and ethmoidal regions. A diagnosis of malignancy was made. Examination of the chest showed probable metastases.

The usual laboratory tests were negative. Ophthalmoscopic examination showed a choked disk, with enormous dilatation of the vessels from pressure behind. The mass

in the orbit prevented further examination. The condition of the patient was regarded as hopeless.

Patient was treated with roentgen ray on October 27 after which the pain was markedly less, and on November 22 he showed marked improvement and no pain. The treated area was apparently normal. The patient was well four months after treatment was instituted. The tumor was probably a lymphosarcoma.

The technique is two half-skin doses at one month interval. No attempt was made at crossfire.

CASE II. Female, aged forty-two. Left breast was amputated two years ago for a tumor of unknown duration. Recurrence in the scar and in the other breast about a year later. Backache for about a year. Patient bedridden.

Patient was admitted to hospital on January 22, 1923; was markedly emaciated and complained of severe pain in the region of the lumbar spine and down the thigh. There were multiple skin nodes along operative incision, and there was involvement of the right breast forming a tumor $1\frac{1}{2} \times 2$ in. There was also involvement of the supraclavicular nodes on both sides.

Roentgen examination showed metastases to the outer third of the left clavicle, both lungs, head and neck of the left humerus, the entire glenoid region of the scapula, with destruction of the fourth and fifth lumbar vertebrae, the sacroiliac joints and ischium.

The microscopic report was adenocarcinoma, and the condition regarded as hopeless.

Treatment was instituted on January 31, 1923, and on December 1 the patient was clinically well. The technique used was: Skin doses over the right hip and sacrum. Sub-erythemas over the rest of the pelvis and other involved bones using 200 kv. and copper filter. Chest treated with fractional doses using 9 in. back-up and 3 mm. Al. filter. There was complete disappearance of all nodes; the right breast was normal, except for a sclerotic mass 1 in. in diameter. The patient weighed 167 lbs.

CASE III. Male, aged seventy. Admitted to the clinic February 21, 1923, with diagnosis of carcinoma of the stomach.

About a year ago noticed pain in epigastrium which was aggravated by food, with occasional vomiting; loss of weight, and weakness.

Roentgen examination of the gastrointestinal tract on February 6, 1923, showed a retention of fully two-thirds of the morning barium meal. There was a marked filling defect along the greater curvature and pars media. Examination of the chest showed metastases into the mediastinum. Condition considered hopeless because of the patient's general condition and the extent of involvement of the stomach.

Patient was treated with roentgen ray, and examined again on October 9, 1923, at which time there was no six-hour retention. There was, however, some retention in the conus duodenalis. The pylorus and first portion of the duodenum were displaced unduly to the left. The filling defect along the greater curvature noted in previous examination was not outlined at this examination. Metastases in the chest were increasing, however.

January, 1924, the patient is symptom-free. Three erythema doses were given at fourteen-day intervals over the anterior abdominal wall, covering the region of the stomach; no crossfire.

CASE IV. Male, aged sixty-six. Patient admitted August 12 as an acute surgical emergency with a diagnosis of intestinal obstruction. Complained of intermittent hematuria for about a year and a half.

Exploration of the abdomen revealed a mass in the region of the right kidney, about 7 in. long and 5 in. wide, which was considered inoperable because of adhesions. The growth seemed to have infiltrated all structures in the vicinity. No biopsy was made. Condition considered hopeless.

Patient was referred for roentgen treatment. On October 3, a mass was noted beneath a right rectus incision about 8×4 in. There was no evidence of metastases into the chest or bones.

On January 1 there was no evidence of bleeding; the tumor was markedly reduced in size; patient gained in weight and had no complaints.

The treatment consisted of one full dose through copper, anterior and lateral, and

one erythema dose through aluminum, posterior, at weekly intervals. There was no evidence of damage to the spleen or suprarenal.

CASE V. Male, aged sixty-seven. Admitted to hospital on September 3, 1923, with diagnosis of carcinoma of the prostate with metastases into the bladder.

Patient complained of hematuria for four months, and frequency for six months. Treated medically. Gave up work six weeks ago because of weakness and bleeding.

Cystoscopic examination showed the involvement to be mostly in the right lobe of the prostate, extending toward the rectum. All laboratory tests were normal.

Roentgen examination showed metastases into both lungs, and probable metastasis into the lumbar spine. Condition considered inoperable.

Treatment was instituted on September 5. Hematuria stopped on the third day. There has been occasional slight bleeding since. The technique followed was: Three skin doses anterior over the left, center and right suprapubic regions at three-week intervals, one-half dose over the sacrum, two months later.

CASE VI. Male, aged forty-seven. In April, 1922, had appendectomy at another hospital. One week later, a colostomy was done for complete intestinal obstruction. Operation revealed an inoperable carcinoma of the sigmoid.

On admission to this hospital, August 2, 1922, patient was in very poor general condition, emaciated, waxy skin, with a suspicion of jaundice. Examination showed the liver to be 4 cm. below the costal margin, an inguinal colostomy, and edema of the feet and ankles. Condition considered hopeless. All laboratory tests negative.

Roentgen treatment instituted September 26, 1922. In August, 1923, there was bleeding of the rayed colostomy loop. General condition of patient improved steadily. In the middle of November, 1923, there appeared as a late roentgen-ray effect a necrosis of an area 3 × 2 cm., located in the most inferior portion of the lower colostomy loop. Accompanying this was severe pain localized to a segment about 10 cm. in diameter around the colostomy. This necrosis completely healed after two months.

At the present time the skin over the iliac region shows leathery induration. The skin is markedly telangiectatic. Patient has no symptoms referable to carcinoma, and his general condition is fair.

Proctoscopic examination showed stenosis of the gut but no cancer was demonstrable. It may be above the level reached in this examination.

The treatment consisted of four skin doses over the left iliac region in a period of a year. No cross-fire.

CASE VII. Male, aged seventeen. Pain in right hip and buttock, paroxysmal, of two years duration. Noticed a swelling over right hip at about the time pain came on. Pain comes on for a week at a time about once a month.

Admitted to another hospital May 3, 1923, at which time there was a tumor 3 in. in diameter fixed to the posterior aspect of the right ilium. At operation the process seemed to be inflammatory, and what appeared to be an abscess cavity was curetted after removing three sections for microscopic study. These all showed small round-cell sarcoma.

Patient was referred to the Philadelphia General Hospital for radiation. Condition was considered hopeless. On admission to this hospital patient was emaciated and in pain. Right leg was held in flexion-adduction with painful motion. The right hip showed a fungating tumor 5 × 4 in., draining bloody pus.

Roentgen examination showed a mottled appearance with areas of rarefaction in the right iliac bone, the chief involvement being along the sacroiliac articulation. Examination of the chest showed probable metastases.

Following the first series of roentgen treatments the pain completely disappeared, and there followed a complete healing of the sinus and disappearance of the tumor in the ilium. On June 27, 1923, three weeks following the completion of treatment, there was no evidence of disease. Roentgen examination of the chest on July 9, 1923, showed no definite evidence of metastases. Patient is considered clinically well.

Treatment consisted of three half-skin doses at weekly intervals; cross-fire; single

half-dose over the chest. Repetition of this was given four months later as a prophylactic measure.

The tumor was possibly an endothelioma.

SUMMARY

1. Inasmuch as "erythema," "carcinoma" and "sarcoma" doses have no absolute value, dosimetry on a basis of these is an arbitrary technique.

2. In advanced cancer radiation with the technique of fractional doses applied at intervals has given satisfactory results.

3. The supposition is advanced that in more favorable cases of carcinoma a similar technique may be as effective as more intensive, radical therapy.

STUDIES ON THE PHYSICAL FOUNDATIONS OF ROENTGEN-RAY THERAPY

I

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A. INTRODUCTION

WHEN the investigations reported in this paper were undertaken the well-known intensity distribution charts published by Dessauer and Vierheller[1] were used almost exclusively for the control of deep therapy in this country. Besides these charts the only reliable data concerning the physics of deep therapy were those contained in Kroenig and Friedrich's book: "Physikalische und Biologische Grundlagen der Strahlentherapie."[2] As is well known Dessauer's deep curves are quite different from Friedrich's; they give much higher deep intensities for the same working conditions and are also of a very different form. The differences perhaps are accounted for by the difference in the methods of experimentation employed in the two cases, Dessauer and Vierheller having used a photographic method while Friedrich's work was done by means of an ionization chamber. Friedrich's method is to be regarded as the more reliable of the two for biological applications.

On account of these discrepancies we thought it necessary to repeat these measurements using a typical American roentgen-ray transformer. The problems were (1) to find the influence of variations in focal-skin distance, filter and area of field, on the surface and the depth doses for certain conditions of radiation, (2) to measure a set of isodoses, and (3) to determine the right combination of filter and focal distance to obtain the maximal deep effect for a fixed surface dose. Furthermore our investigations concerned the determination of the influence on the ionization current of variations in the shape, size and material of small ionization chambers. To determine accurately the roentgen-ray intensities in the so-called "e"-unit we introduced a small ionization chamber of a special material, so that readings were obtained equal to readings in a pure standard air chamber. The results of these latter investigations will be published in Part II of this paper.

Since the undertaking of the present work many investigations on the same subject have been published by Coliez[3] Duane,[4] Erskine,[5] Failla and Quimby,[6] Friedrich and Körner,[7] Glocker, Rothacker and Schönleber,[8] Grossmann,[9] Holfelder,[10] Jaeger and Rump,[11] Solomon,[12] Wintz and Rump[13] and others.[14,15,16,17,18,19,20]

All of these investigators, except Glocker, used Friedrich's ionization method; their results agree well enough for practical purposes, giving for instance values of between 40 and 45 per cent for the relative deep doses under the following conditions: Potential, 200 kv.; current, 5 ma.; filter, 1 mm. Cu. + 1 mm. Al.; focal distance, 50 cm.; area of field, 20 × 20 cm. In general these values are as much as 10 per cent higher than Friedrich's. The variations are mostly due to differences in the definition of the depth of the ionization chamber within the water phantom, as will be discussed later. In his very careful investigations, Glocker[8] has used both a special photographic method and the biological method of Jüngling. His results obtained by the first method agree with those of Friedrich. The values for the deep effect obtained by the biological method, however, are about 20 per cent lower than those obtained by the ionization method.

The values for the deep effects obtained by our experiments are in fairly close agreement with Friedrich's results although the values for the deep dose are usually somewhat lower. The results are also in fair agreement with those obtained by Glocker's biological method, our values for the deep effect lying intermediate between those obtained by Glocker and by Friedrich. Our results are in sharp disagreement with the results obtained by Dessauer.

B. EXPERIMENTAL TECHNIQUE

In principle the method employed is the same as that used by Kroenig and Friedrich.[2] Two photographs of the arrangement are given in Figure 1. Figure 2 shows a diagram of the apparatus. A water phantom 35 × 35 × 35 cm. was used, the rays from the roentgen tube X entering from the side through a celluloid window 2 mm. thick. The electroscope, of the gold leaf type, was mounted on a double carriage on top of the phantom. It was made of lead walls, 7 mm. thick and for further protection was surrounded by a housing of 1½ mm. lead. The volt sensitivity of the electroscope could be regulated by moving the grounded plate P through the micrometer screw S. The capacity of the electroscope could be changed by the introduction of the ceresin condenser C. The brass tube T contained the wire W connecting the ionization chamber electrode with the electroscope;

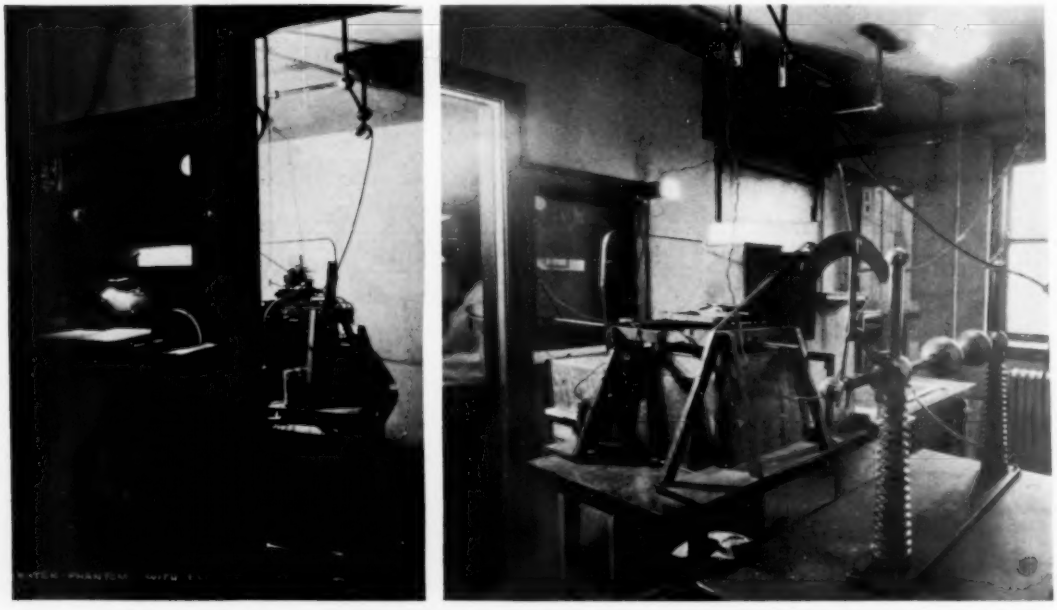


FIG. 1. Arrangement of water phantom and electroscope with observation room.

this tube was filled with ceresin. The main feature of this apparatus is its small capacity (20 cm. without condenser) which allows the use of very small ionization chambers (½ c.c. in volume, or even smaller).

The observer was stationed in a room adjoining that containing the roentgen tube and phantom. From this room he could mechanically move the ionization chamber to any point in a horizontal plane within the phantom, the coordinates of its position being read directly. The shadow of the gold leaf was projected through a window of lead glass to a scale in the observation room where the time of its fall was observed.

The sensitivity of the electroscope was frequently controlled by a battery of 12 volts, this potential being added to the main potential by drawing the switch S_2. The milliammeter used to measure the current through the roentgen tube was also used to read the voltage of this battery, a resistance of 2,400 ohms being introduced in series with it. By this arrangement a reading of 5 ma. indicates a potential of 12 volts and variations in the meter, if they occurred, were automatically compensated by a coincident balancing variation in the calibration of the electroscope. The electroscope was adjusted so that a change of 12 volts in the potential of the leaf caused it to move over the same number of divisions on the scale over which its fall was observed.

The leakage due to scattering of roentgen rays into the electroscope system, etc., was determined both by placing a lead plate in front of the port of entry, and by surrounding the ionization chamber with lead; no appreciable difference in the scattered intensity was found in the two cases. Even for the faintest radiation the scattered intensity was not more than a few per cent of the total intensity.

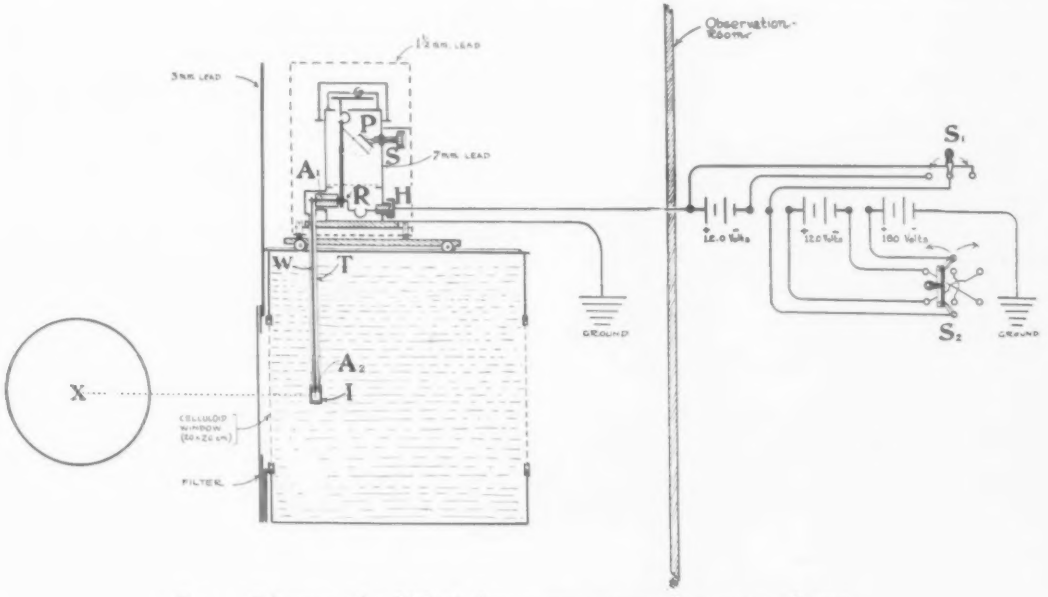


FIG. 2. Diagram of gold leaf electroscope mounted on water phantom.

Unless otherwise stated the investigations were carried out by means of an ionization chamber made of redmanol (artificial amber) coated inside with a layer of graphite $\frac{1}{100}$ mm. in thickness; the chamber was cylindrical in shape (length, 1.06 cm.; diameter, 0.80 cm.) and had a volume of ½ c.c. During our investigations of deep effects, several ionization chambers of different shapes, sizes and materials, were compared, as described in Section D.

We have used a Kelley-Koett mechanically rectified 200 kv. transformer of the type XA for the production of the high potential. The tube employed was the Coolidge deep therapy tube. The roentgen-

ray intensity was defined by the current through the tube and by the high potential. The latter was measured by a 12.5 cm. sphere gap, and was kept constant during the work by keeping the primary voltage constant.

the reciprocal, termed "time of treatment." This is given in arbitrary units, using as the unit the time (approximately one hour) which is necessary to produce a light erythema under the following conditions:

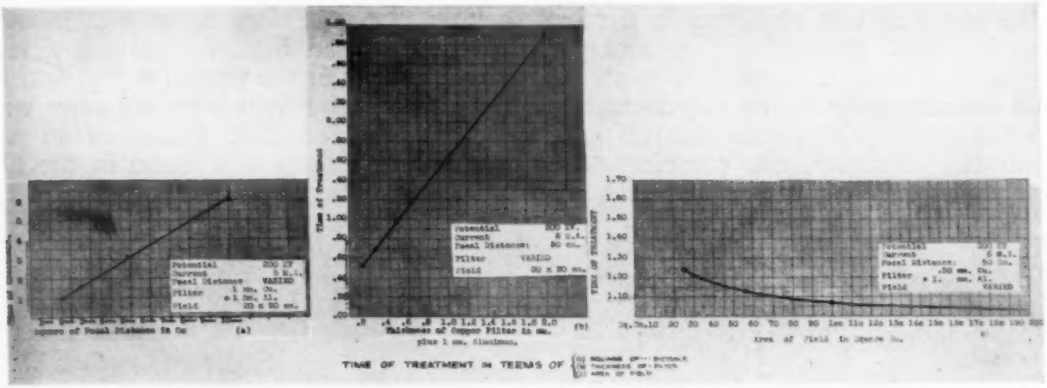


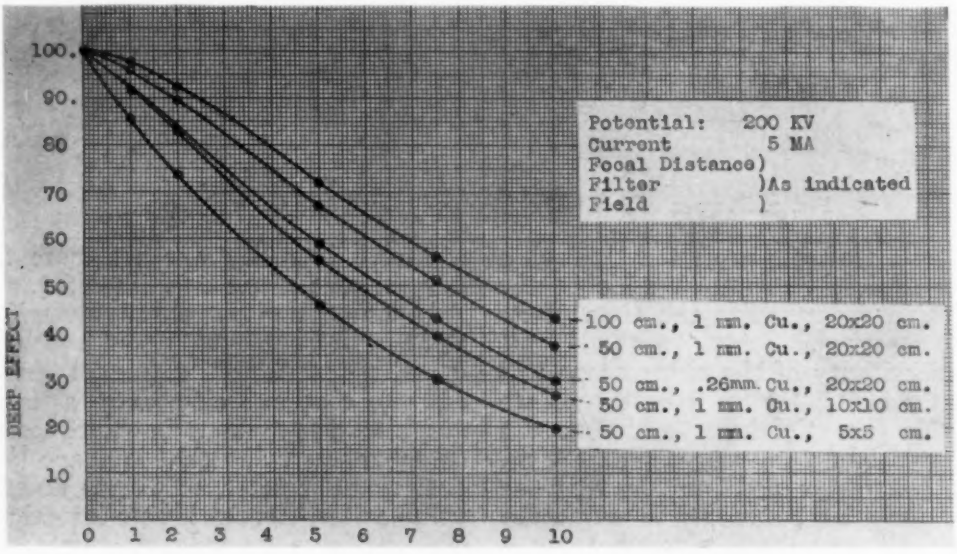
FIG. 3. Curves showing time of treatment in terms of focal distance (a) thickness of filter (b) and area of field (c).

C. THE SURFACE INTENSITY IN TERMS OF FOCAL DISTANCE, THICKNESS OF FILTER AND AREA OF FIELD

The curves in Figure 3 illustrate the relationship of the surface intensity to

Potential, 200 kv.; current, 5 ma.; focal distance, 50 cm.; filter, 0.5 mm. Cu. + 1 mm. Al., and area of field, 20 × 20 cm.

Each of the curves in Figure 3 corresponds to the variation of one of the three variables: focal distance (curve a) filter



Depth in cm.

FIG. 4. Typical central deep curves in water.

the focal distance, thickness of filter, and area of field; these curves are all determined at a fixed potential (200 kv.) and a fixed current (5 ma.). Instead of surface intensity the variable used is

(curve b) and area of field (curve c). The shape of each curve is to such an extent independent of the special values of the two fixed conditions that the curves can be used for practically all combinations of

focal distance, filter and port of entry, which are usually employed in deep therapy.

The procedure to obtain the proper time of radiation under conditions differing from the standard conditions, under which the erythema dose for a given apparatus is known, is to find the ratio between the times necessary to produce an equal effect with (1) the new focal skin distance and the distance used in determining the erythema dose (curve a), (2) the new filter and that used in determining the erythema dose (curve b), (3) the new area of field and that used in determining the erythema dose (curve c). The product of these three ratios gives the factor by which the old erythema-time must be multiplied to give the erythema-time under the new conditions. This may be illustrated by Table I on following page.

D. DETERMINATION OF ISODOSES

In order to ascertain to what extent the shape of the deep curve is dependent upon the size and shape of the ionization chamber, deep curves have been determined under certain fixed conditions, employing different ionization chambers. These were made of redmanol, wood and graphite, and were cylindrical in shape, their dimensions varying from 0.40 cm. in length by 1.80 cm. in diameter to 2.0 cm. in length by 0.56 cm. in diameter. Furthermore the original Friedrich horn ionization chamber (length, 1.7 cm., diamter, 1.5 cm.) was used. The volume of the different chambers varied from ½ c.c. to 3 c.

All these different ionization chambers gave practically the same deep curves for fixed conditions, when the depth was

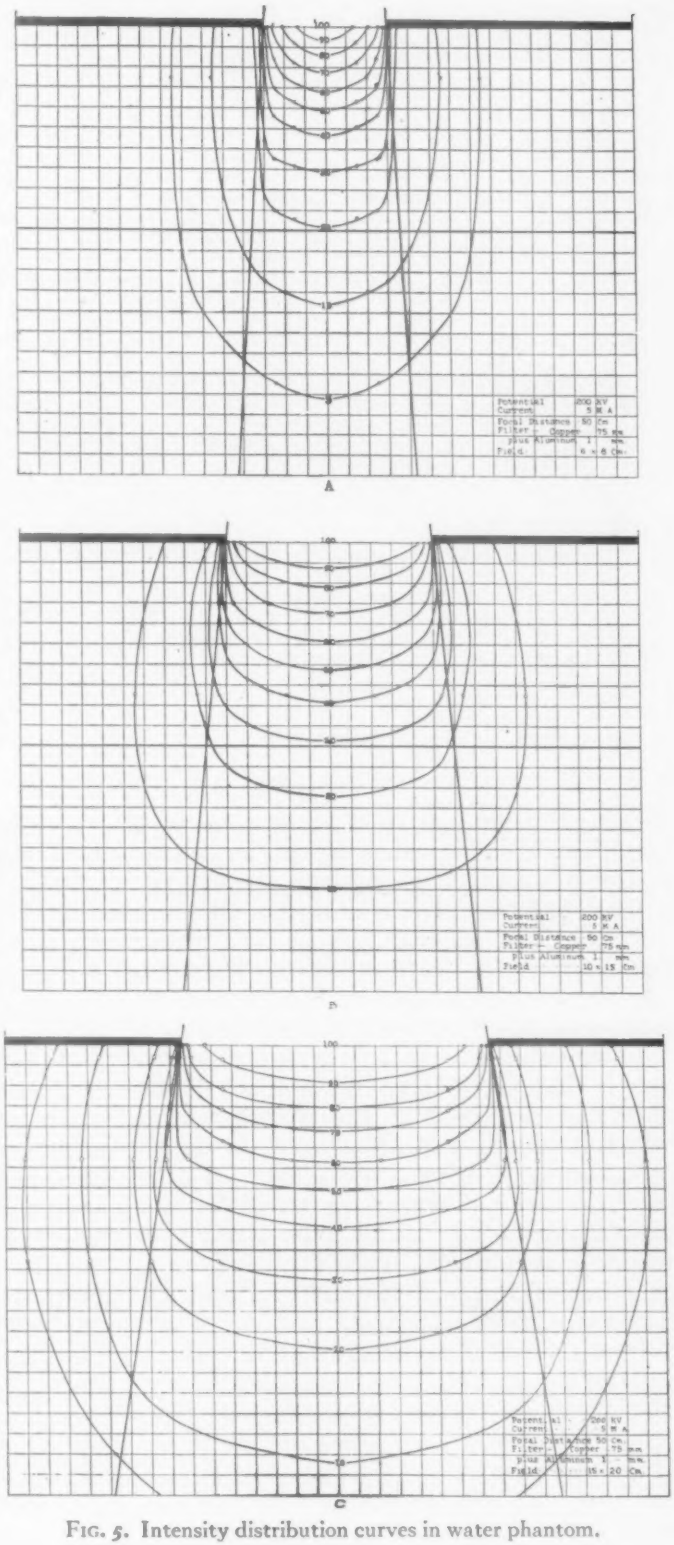


FIG. 5. Intensity distribution curves in water phantom.

TABLE I

	Standard Conditions	New Conditions
Potential.....	200 kv.	200 kv.
Current.....	5 ma.	5 ma.
Focal distance...	50 cm.	40 cm.
Filter.....	0.68 mm. Cu. + 1 mm. Al.	0.50 mm. Cu. + 1 mm. Al.
Area of field.....	14 × 14 cm.	8 × 8 cm.
Erythema time..	85 min.	$85 \times \frac{1.00}{1.60} \times \frac{1.00}{1.22} \times \frac{1.11}{1.03} = 47$ min.

from its center, whereas according to what was stated above, the depth should be measured from the front surface.

The whole intensity distribution within the water phantom for three typical conditions has been measured. The results are plotted in the type of curves known as Isodoses (Fig. 5).

Isodoses curves corresponding to other working conditions may be constructed with fair accuracy by means of the curves in Figure 6, Section E.

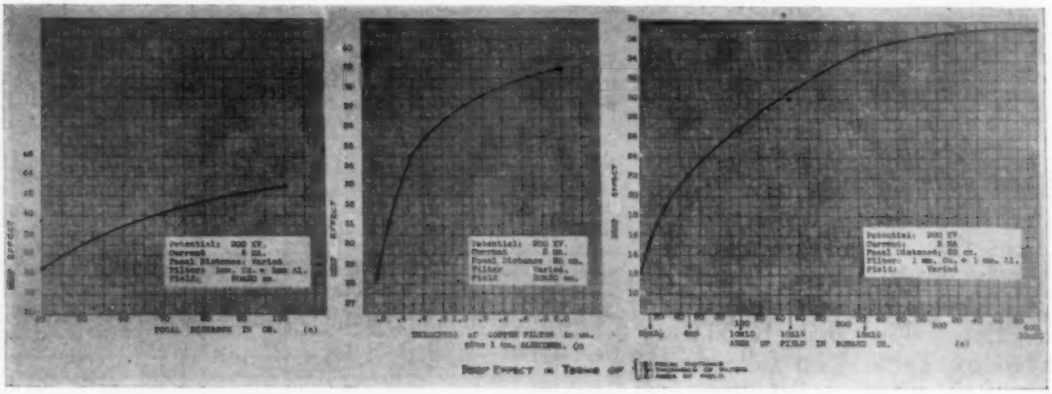


FIG. 6. Curves showing deep effect in terms of focal distance (a) filter (b) and area of field (c).

measured from the front surface of each chamber. This indicates that an ionization chamber of finite dimensions records the intensity at its front surface; all deep curves given in this paper are made accordingly. As will be seen from Figure 4, the deep curves especially for large openings are comparatively flat near the surface. The value measured for the surface intensity is therefore nearly independent of the choice of the point of the chamber from which its depth is measured. At the depth of 10 cm., however, the choice of this point is of importance; the value for the deep effect may be found to be as much as 10 per cent too high, when the depth of a chamber of the size of that of Friedrich is measured from its center.

It was noted in Section A that our values for the deep effects are somewhat lower than those obtained by most other investigators who have used the same method. These differences can be accounted for partly by the fact that these investigators have measured the depth of the chamber

E. THE DEEP EFFECT IN TERMS OF FOCAL DISTANCE, THICKNESS OF FILTER AND AREA OF FIELD

Each one of the curves in Figure 6 gives the deep effect (ratio of the intensity at 10 cm. depth to the intensity at the surface) in terms of one of the variables, focal distance (curve a, Fig. 6), filter (curve b) and area of field (curve c) for fixed values of the other two.

The deep effect corresponding to an arbitrary set of conditions is determined by the curves a, b, c, using the same procedure as that described in Section C. The following example will serve as an illustration:

TABLE II

	Standard Conditions	New Conditions
Potential.....	200 kv.	200 kv.
Current.....	5 ma.	5 ma.
Focal distance...	40 cm.	50 cm.
Filter.....	1 mm. Cu. + 1 mm. Al.	0.75 mm. Cu. + 1 mm. Al.
Area of field.....	20 × 20 cm.	$7\frac{1}{2} \times 7\frac{1}{2}$ cm.
Deep effect.....	34.6	$34.6 \times \frac{3.70}{3.46} \times \frac{3.62}{3.70} \times \frac{2.30}{3.72} = 21.7$

By the procedure described the curves of Figure 6 will give the deep effect with sufficient accuracy for the combinations of distance, filter and opening which are usually employed in deep therapy (area of field should be over 30 sq. cm.).

When the deep effect has been determined as described above, the central deep curves can be constructed by using one of the curves of Figure 4 as a model. Finally the Isodoses curves can be drawn with one of the charts of Figure 5 as a model.

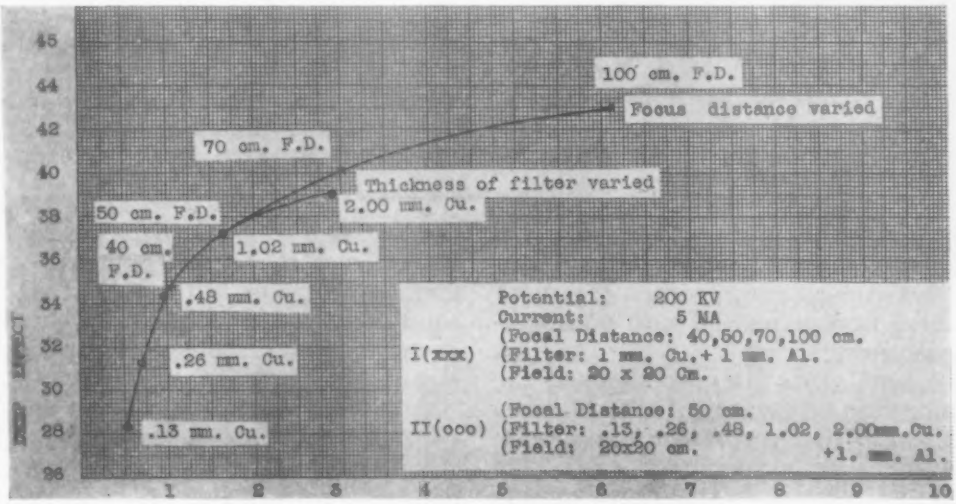


FIG. 7. Curves showing deep effects in terms of time of treatment for variations of focal distance and filter.

F. CHOICE OF RIGHT COMBINATION OF FILTER AND FOCAL DISTANCE

We understand the right combination of filter and focal distance to be that combination by which the largest possible deep effect is obtained for a fixed value of the surface dose. The right combination is determined by plotting the deep effect as a function of the time of treatment, the variations in this time being obtained in one curve by a variation of the filter, in another by a variation in the focal distance. This is done in Figure 7 for the case of a 20 × 20 cm. opening.

These curves have been plotted by the use of the curves a and b in Figure 3 and Figure 6. Portions of equal slope in the two curves give the right combination of filter and focal distance. It can be seen that a focal distance of between 40 and 50 cm. should be combined with a filter of between ½ and 1 mm. Cu. Increase in deep effect is equally effected by an increase in filter thickness or in focal distance. When a filter of 1 mm. Cu. is used, an increase in deep effect should be produced by increasing the focal distance.

In conclusion we wish to express our appreciation of the assistance offered by Mr. I. E. Beasley, C. Nussbaum, Ph.D., and Mr. B. Rosen in the experimental part of this work, and by Mr. V. B. Seitz, chief of the electromechanical engineering department of the Cleveland Clinic in the construction of the apparatus.

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THE ROENTGEN RAY IN THE TREATMENT OF CARBUNCLES AND OTHER INFECTIONS*

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IT is eighteen years since Coyle reported 3 cases of small carbuncles successfully treated with the roentgen ray, with early relief from pain, and with no breaking down or discharge.

Frick, four years later, condemned the roentgen ray in the treatment of carbuncles.

Dunham in 1916 reported the successful treatment of 67 consecutive cases. He found relief from pain and improvement in the patients' general condition within forty-eight hours after the treatment. In some there was little or no discharge; in others there was some breaking down and discharge; but in the majority the carbuncle took on the appearance of a single abscess which made thorough drainage, through a small opening, possible. Dunham concluded that nothing in all roentgen therapy gave such positive and uniformly perfect results as the treatment of a carbuncle.

In 1917 Dr. Ross of Philadelphia reported a very extensive carbuncle of the face cured with the roentgen ray.

From 1917 to 1923 there seems to have been practically nothing in the literature in reference to this work. Lewis of New York, in an excellent article in "Annals of Surgery," November, 1923, reported 16 cases of carbuncle treated with the roentgen ray. Only 2 cases were operated upon. He believes that the roentgen ray is the method of choice in the treatment of this condition. He could find only three references in the literature to the use of radiation in the treatment of carbuncles.

A review of the literature shows that many different methods of treatment are still being used. The leucodescent light, painting with collodion, vaccines, zinc ionization, various cleansing lotions—especially Dakin's—crucial incision with flap undermining, excision, and extensive cauterization are still advocated. Several recent articles by reliable men, citing cases in which radical excision or cauterization was followed by a long drawn out convalescence, with marked scarring and deformity, at times even requiring plastic work, seem to show that the value of the roentgen ray in the treatment of carbuncles and allied conditions is not generally known. Neither in these articles nor, so far as we are aware, in any of the new textbooks on surgery is the use of the roentgen ray in the treatment of carbuncles mentioned.

Since Dunham's article in 1916 we have treated a fairly large number of boils and small carbuncles; but during the past eighteen months we have treated 9 large,

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extensive, ulcerating, sloughing carbuncles. In one of these it was thought that the outcome would be fatal. The carbuncle was on the face where the mortality is rather high. This patient, a man aged sixty-three, had a very large carbuncle of two weeks' duration. There was only a slight watery discharge. The sinuses, six or eight in number, extended from the hair line in the temporal area to the angle of the jaw. The swelling and induration extended from the left of the mid-line of the scalp in the frontoparietal area down to the left clavicle; and from the nose to the ear. The left eye was practically closed. His temperature was 103.2°, and for several days frequent hypodermics of morphin had been necessary for the control of pain. This man was so weak and appeared so ill clinically that we were afraid to give a heavy radiation over this entire area. One of the consulting surgeons, who had recently had a very painful carbuncle on his forearm treated with the roentgen ray, insisted that the treatment be given.

About twelve hours after the treatment the pain was greatly relieved. Within twenty-four hours there was practically no pain; his general condition was definitely improved, and the lesion was softer. At this time and for two or three days there was a heavy purulent discharge. The fifth day after the first treatment the patient was discharged from the hospital. There was practically no swelling, no induration except a very small area just above the clavicle; the sinuses were shallow, clean, and beginning to heal. One week later a very small abscess just above the clavicle was opened, and an uneventful recovery followed. This patient was about as ill as any carbuncle case can be, and recover. We believe that radiation relieved his pain, started up a purulent discharge, and limited what was a rapidly extending serious lesion. We know that he recovered and that very little scarring occurred.

In all of our cases the pain was almost entirely relieved in from six to twenty-four hours. In 5 of the 9 severe carbuncles, the pathology changed rapidly, usually within two days, into a fairly large central abscess which drained freely for two or three days and healing followed promptly. The other 3 cases had lesions more or less similar to the case reported in detail, but were not so large or serious.

In the very large carbuncles where there was marked swelling, induration, and edema, there were already numerous open sinuses when the patients came under observation. There was rather marked sloughing, but only a slight watery discharge. Clinically these patients appeared ill and complained bitterly of the pain which could be relieved only by morphin. Even in these cases the pain was relieved by the roentgen treatment in from twelve to twenty-four hours. The discharge changed to the sero-purulent type, and within two days the clinical picture was entirely changed. The involved area rapidly became softer, smaller, and cleaner. The skin wrinkled over the area as if a large amount of material had been mechanically forced out of the tissues.

In only 1 case was there any extension of the pathology following radiation. This carbuncle was located in the parotid area and too small a dose of the ray was used on account of fear of a parotid reaction in an extensive surrounding infection. Since this experience we have disregarded the parotid in infections in this area. A larger dose four days later was followed by good results.

In several cases of moderate sized carbuncles of the forearm, with red lines of lymphangitis extending nearly to the axilla, and severe pain throughout the entire arm, shoulder, and axilla, the pain was relieved and the red lines gone within eighteen to twenty-four hours following radiation. We have no explanation to offer for the early relief of pain and the rapid disappearance of lines of lymphangitis extending some distance from the area treated, except the mechanical relief of tension in the tissues. This is probably brought about in several different ways. The increased discharge gives better drainage with lessened tension in the inflamed areas. In carbuncles where there are several pus pockets, they are under different tensions and some are more painful than others. Coalescence into one large abscess naturally lessens this tension to

some extent. This does not, however, explain many cases where the pain is entirely relieved before there has been any softening or any discharge. The lymphangitis in several cases has also entirely disappeared before the occurrence of either of the above conditions. Of course the destruction of certain cellular elements in the inflamed area, particularly lymphatic tissues, evidently occurs; but there must be something more than the mechanical effect that this would bring about. In some of the smaller carbuncles where the pain was quickly relieved, the lesion gradually disappeared without any breaking down or discharge.

It was noted that in the type of inflammation the action of the roentgen ray is particularly striking in which there is lymphangitis, and where the inflammation or cellulitis is almost of the erysipelas type. For this reason we believe that the roentgen ray may be of value in erysipelas, and hope to make a later report on this after we have thoroughly tried it out.

There was very little scarring in any case, and we believe that the duration of the disease was invariably shortened.

The following technique was used in practically all the cases as soon as the patient was seen:
4 ma., 9 in. spark gap, 8 min. with 9 mm. of aluminum; 9 in. distance; and half this dose was repeated about the fourth day if necessary. The area treated included at least 1 in. of healthy tissue around the lesion. Just as soon as any part of the indurated area showed any softening, a small incision was made. The discharging sinus or sinuses were dressed daily, but no chemicals or lotions of any kind were applied.

Three localized areas of infection due to other conditions than carbuncles were treated, and responded about as did the carbuncles.

There was 1 case of an extensive infection of the subcutaneous tissues of the neck following a cut on the back of the neck made by a rough collar button. This case responded to treatment practically the same as did the carbuncles.

Two stone bruises, one palmar abscess, and one ischio-rectal abscess gave excellent results. The ischio-rectal case had two years previously spent two weeks in a hospital, waiting, suffering, and poulticing, before a similar abscess was drained surgically. This time he was seen two days after the pain started. He had a large, hard, irregular, tender area to the left of the anus and rectum. A prostatic chair was used in order to give a heavy treatment directly into this area. Sixteen hours later the abscess ruptured, and three days later he returned to work.

There was not a single failure in this group, and only one failure in the large series of small carbuncles and boils. In one patient, a boy about fourteen years old, with multiple boils in the axilla, we were unable to get a result. The condition was so extremely painful that the arm could not be gotten in a position to properly expose the area to the ray.

One case of an acute subdeltoid bursitis was treated. No result was expected in this condition on account of the very different pathology. The treatment had absolutely no effect on the pain or course of the disease.

We do not believe that every carbuncle will respond as beautifully to roentgen-ray treatment as did the cases in this series, and of course this is too small a series of cases from which to draw any definite conclusions. However, the following observations appear to be warranted:

(1) Every carbuncle should have roentgen therapy as soon as the diagnosis is made.

(2) When softening first occurs a small incision should be made.

(3) The pain is greatly relieved in nearly all cases and entirely relieved in many.

(4) The infection is usually limited and the duration of the disease shortened.

(5) There is very little scarring following this method of treatment and no danger or pain associated with the radiation itself.

(6) Other localized infections of the skin and subcutaneous tissues respond very similarly to the roentgen ray.

(7) Areas of lymphangitis extending for some distance away from the localized lesion usually disappear a few hours after the treatment.

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THE MEASUREMENT OF AIR-IONIZATION BY MEANS OF A SMALL CHAMBER MADE OF BAKELITE AND AMBROID FOR USE IN THE STUDY OF ROENTGEN-RAY DOSAGE

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IT is quite generally accepted that the best method known at present for determining the dosage of roentgen rays at various depths in a biological subject is that of air-ionization measurements at these depths, either in the specimen itself or in a "phantom" of water or other suitable material. These measurements are usually made by means of a small closed ionization chamber made of substances containing only elements of low atomic weight. Such chambers are used in the iontoquantimeter of Kroenig and Friedrich,[1] who studied their behavior under both filtered and unfiltered rays, and who state that they operate with a degree of consistency sufficient for biological purposes.

The writer has constructed a small chamber of ambroid and bakelite for use in experiments on the dosage of small animals with relatively soft rays, and has studied it by use of a method, and under conditions which, in his opinion, assure a reasonable degree of accuracy, and avoid some possible sources of error in the work referred to above.

It is the purpose of this paper to describe the method and apparatus used; to call attention to some of the precautions which must be observed in experiments of this kind; and to present the results of the study of this particular chamber in some detail.

[1] Kroenig and Friedrich. The Principles of Physics and Biology of Radiation. New York, 1922.

THEORY OF THE CHAMBER OF LIGHT ELEMENTS

Because of the presence of scattered and secondary characteristic radiation, the tissue of the subject is, in general, traversed by rays in all directions. The completely closed chamber, as nearly as possible equally transparent in all directions, is, therefore, the only one which is feasible. In order that the chamber may function as nearly as possible independently of the hardness of the ray, it should be made of materials containing only elements of sufficiently low atomic weight to exhibit no characteristic phenomena over the range of wave-lengths to be encountered.

The average intensity of radiation is, in general, less inside the chamber than outside because of absorption of the walls. Although negligible for hard rays, this effect may be considerable for very soft rays, and it must be taken into account when the chamber is used to measure surface dosage. Since the chamber walls, being made of light substances, act much like the tissue of the subject or phantom in the matter of absorption, they may be considered either as part of the chamber or as a part of the tissue, when measurements are made within the volume of the tissue. It makes little difference in this case, therefore, whether or not the absorption of the walls is taken into account,

because the error will not be so great, in general, as that resulting from the uncertainty in effective position of the chamber. This uncertainty is minimized by making the chamber as small as practicable.

The rate of ionization of the air in the chamber may not be the same as that of a similar portion of air surrounded only by air of great extent under the influence of the same radiation, because equilibrium may not exist between the air and the walls in the interchange of fast-moving electrons; and the discrepancy may be a function of wave-length. Although it is quite generally believed, as a result of many experiments, that air and the light materials of which the walls consist behave much alike in the matters of electron-emission as a function of energy absorbed from the ray, and mass-absorption coefficient of the energy of fast-moving electrons, yet, even if we assume for the sake of argument an ideal case in which the chamber walls consist only of air of great density, solidified air perhaps, there would still remain (since the dimensions of the chamber are not large compared to the electron ranges) a very complex problem involving the density-distribution of the air, and the electron-ranges, which vary, of course, with hardness of the ray.

A knowledge of the operating characteristics of the chamber must, therefore, be based on experimental calibration.

THE EXPERIMENTAL CHAMBER

Figure 11 shows the essential features of the chamber in longitudinal section. The central electrode, A, is a rod of bakelite

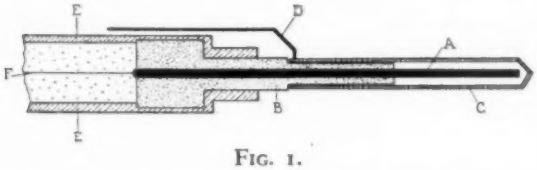

FIG. 1.

1.6 mm. in diameter, coated with india ink. It projects to a distance of 2.7 cm. from the end of the insulating cylinder of ambroid, B, which supports it. The tube, C, of bakelite coated inside with india ink, serves as the other electrode. It fits nicely over the insulator, B, and is held in place by the insulated spring-brass wire, D, through which it is connected to a battery. This tube is 4.8 mm. in internal diameter, the cylindrical wall being about .25 mm. thick, and it projects beyond the insulator to a distance of 2.86 cm., extreme inside measurement. The chamber contains about .450 c.c. of air. The ambroid piece, B, is mounted in a grounded brass tube, E, 56 cm. long, filled with paraffin through which runs the fine wire, F, from the central electrode. It was found by experiment that 100 volts suffice to saturate the current in this chamber with the most intense radiation available.

THE STANDARD CHAMBER

The construction of the standard chamber is shown in Figure 2. It is a rectangular brass box, 15 cm. long, 10 cm. high, and of width variable between 3.2

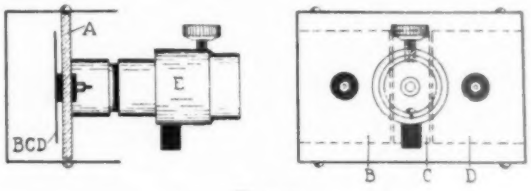

FIG. 2.

and 7.0 cm. Inside this box, close to side A, and parallel to it, three insulated rectangular flat-plate electrodes, B, C and D, are so held that their exposed surfaces lie in the same plane, and that the middle one, C, 2.54 cm. in width, is separated from each of the others by a distance of .06 cm. The chamber may be attached to the measuring apparatus by means of extension E. In use, the box is maintained at high potential by a battery, the middle plate is connected to the electrometer, and the other plates are put to earth.

With a chamber of this type, it is possible to make ionization measurements free from error; the proper conditions of its use must be carefully observed however. The roentgen-ray beam which passes through the chamber must be restricted to a reasonable degree of parallelism by the use of at least two stops, one near the tube, and the other close to the chamber, generally smaller than the first and with aperture of accurately determined cross-

section. These stops must be so arranged that the beam traverses the chamber axially, and at a distance from the electrodes and other parts such that no fast-moving electrons emitted by the ionized air can reach them. This distance depends upon the hardness of the ray. The chamber must be protected, of course, from all stray radiation, and the beam, after traversing the chamber, must be allowed to continue freely to a considerable distance, lest part of it be returned to the chamber by scattering. It must be demonstrated, further, that the potential used on the chamber is sufficient to give saturation, and that that part of the electric field within the chamber which has to do with the middle electrode, is parallel within the allowable limit of error.

The volume of air upon which ionization measurements are made with this chamber is equivalent to a cylinder of length equal to the width of the middle electrode plus one-half of the widths of the spaces between it and the two neighboring electrodes, and of cross-section equal to the product of the area of the standard aperture and the square of the ratio of the distances of the target from the middle of the chamber and the standard aperture respectively. It is not essential that the distance from the target to the middle of the chamber be determined accurately, so long as the value used in this ratio is taken as the effective target distance in comparison experiments. A slight error in this distance means merely a corresponding error in the amount of air through which the ray must pass and in which the soft rays may be absorbed appreciably.

THE ELECTROMETER AND ACCESSORY APPARATUS

The measuring unit, consisting of a specially designed electrometer of the Bumsted type, two standard condensers, and the necessary contact keys, is attached to one end of a lead-lined steel tube, 150 cm. long, which is carried in a horizontal position on a very heavy clamp-stand. To the other end of the steel tube may be attached either the standard chamber, or a unit consisting of two mechanical joints at right angles to each other, to which the tube E (Fig. 1), carrying the experimental chamber may be attached. Electrical connection of the chambers with the electrometer is established through the mechanical joints and the steel tube by means of amber-insulated wires. This arrangement serves nicely for adjusting the chambers to the desired positions, and it avoids the troubles with insulation losses which are encountered when flexible conductors are used. Insulation losses are further eliminated by using the compensation method with condenser and potentiometer for the measurements, so that the insulated system is kept at all times at zero potential.

THE SOURCE OF RAYS

The rays are produced in a standard Coolidge tube with tungsten target, operating on transformer current rectified by kenetrons, and governed by a somewhat modified Victor-Kearsley stabilizer.[1] When in operation, the stabilizer-adjustment and the field of the primary current generator are constantly under the control of an assistant. The constancy of operation of the plant under all conditions has been checked up by many hundreds of ionization determinations with the standard chamber over a period of a year. During this time, various parts of the plant—the tube, the kenetrons, and the stabilizer; as well as the electrometer, chamber, and standard condensers have been newly adjusted. It has been found that the whole outfit can be relied upon to reproduce rays at peak voltages between 20,000 and 95,000 with an error not exceeding 2 per cent. The importance of this will become clear when the method of the present experiments is considered.

THE GENERAL ARRANGEMENT OF THE EXPERIMENTS

Figure 3 shows, in horizontal section, the arrangement for using the standard chamber. The roentgen-ray tube is enclosed in a lead-lined box in one side of which is an aperture covered by a slide which carries

[1] The operation of this plant is briefly discussed by the writer in a paper entitled "The Effect of Tube-lead Capacitance on the Efficiency of X-ray Apparatus in which Inverse Current is Suppressed by Kenetrons." *Proc. Am. Phys. Soc., Phys. Rev.*, 21, 477–478.

the filters, and the first lead stop, A, which is about 34 cm. from the target. Stops with various apertures were used as described later. The standard chamber, B, the middle of which is one meter from the target, is protected by a lead-lined box, C, in the front of which is an aperture covered by a slide for carrying the second stop, D, which is 90 cm. from the target. This second stop, for use with the standard chamber, has a circular aperture, the area of which is .102 sq. cm.

When the standard chamber is removed, the experimental chamber may be put in its place at the same target distance. In this case, the second stop, D, described above, is replaced by another stop with

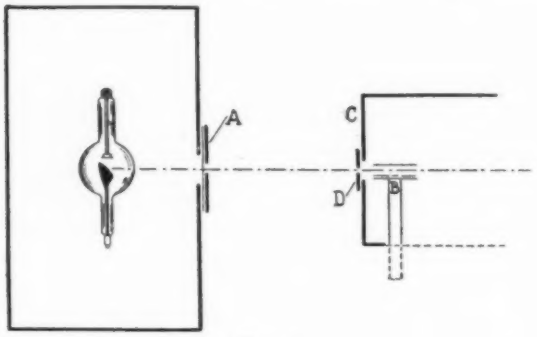

FIG. 3.

rectangular aperture 2.5 cm. × 7.5 cm.; sufficiently large to expose the whole chamber and a considerable field around it, but not so large as to allow any rays to fall upon the inner surface of the box, C. Except when otherwise stated, the experimental chamber is so oriented that rays traverse it in a direction perpendicular to its axis. In the experiments on the effect of varying the angle of incidence of the rays, described later, the experimental chamber is used without the box, C.

EXPERIMENTS WITH THE STANDARD CHAMBER

Each aluminium filter used in the experiments described in this paper was selected carefully on the basis of its uniformity over the region exposed by the aperture in the first stop, A (Fig. 3), as demonstrated by the constancy of ionization measurements when various parts of this region of the filter were used with a special stop of small aperture. Each filter-combination is made up always of the same sheets similarly placed with respect to the aperture. It was found that, in general, filters cut from neighboring parts of the same sheet vary considerably in effective thickness.

The parallelism of the electric field over the region of the middle electrode of the standard chamber was demonstrated by the constancy of the ionization current when a narrow beam of very soft ray traversed different parts of this field. The ray, produced at 20 kv., was filtered to reduce the intensity to a point where there could be no question of saturation of the current, and the path of the ray was varied, relatively to the chamber, from the middle of the chamber (opened up to its greatest width of 7 cm.) to within .5 cm. of the electrodes, by moving the chamber in a direction perpendicular to ray. No discrepancies greater than the assumed experimental error were found and the slight differences were not systematic.

The minimum safe distance between a beam of hard rays and the walls of the standard chamber was determined by an experiment similar to the one just described except that 95-kv. rays filtered through 5 mm. of aluminium were used. The ionization current remained constant for all distances of the extreme edge of the beam from the electrodes exceeding 1.2 cm. When the distance was decreased to .6 cm., the current decreased by about 8 per cent.[1] Subsequent experiments were made with a clearance of at least 1.5 cm. for all rays.

The saturation of ionization currents in the standard chamber by the available difference of potential of 600 volts was demonstrated by the constancy of the current, when 300 and 600 volts were used alternately, with rays many times as intense as those to be used subsequently.

The influence of the size of the first aperture, A (Fig. 3), was studied carefully. Although most of the rays issue from the focal spot of the target, a considerable portion may come from other parts of the target, from the glass, and from the lead

[1] The chamber described by Kroenig and Friedrich (p. 445) provided a clearance of .6 cm. of each side. This suggests the possibility of an error as great as 16 per cent in the measurement of hard rays with no corresponding error in the case of soft rays.

lining of the box which surrounds the tube. The intensity of radiation at an external point should depend, therefore, somewhat on the size of the first aperture, and also, to a less extent, on the degree of alignment of the focal spot, the aperture, and the external point, particularly if the aperture is small. For any given adjustment of the aperture, this alignment may be appreciably different for two external points as far apart as the length of the experimental chamber. Four apertures were investigated—the first, circular, 1.25 cm. in diameter; the others 2.5 cm. wide, and 2.5 cm., 5 cm., and 7.5 cm. long respectively. In the first test, each of these apertures was aligned centrally with the beam of roentgen ray entering the chamber. With 95 kv. rays, a regular increase of 4 per cent was observed in the ionization current corresponding to each increment of aperture. The change was considerably less for soft rays. In the second test, the effect of eccentric alignment of each aperture was studied, the amount of displacement depending on the geometrical relation of the length of the experimental chamber and the target distances of the chamber and the stop. The effect of eccentricity was considerable, but the mean value of the ionization currents when the displacements were in opposite directions was found to coincide closely with that corresponding to a central position of the aperture only in the case of the two largest apertures. Accordingly, the aperture 2.5 cm. wide and 5 cm. long was used with both chambers in subsequent experiments.[1]

COMPARISON OF THE EXPERIMENTAL CHAMBER WITH THE STANDARD CHAMBER

The measurements which serve as a basis of comparison of the two chambers were taken *successively* rather than *simultaneously;* the experiment differing in this respect from that of Kroenig and Friedrich. If readings are taken simultaneously, one avoids, of course, the errors caused by inconstancy in the production of rays, but it was decided on the basis of tests described above that errors from this source were more improbable and more easily discoverable than those which might arise from the use of two beams considerably different in direction, with individual apertures, and filters.

The results of comparing the chambers with various rays are shown in Table I. The quality of the ray is indicated by the peak voltage, shown in column 2, and by the number of millimeters of aluminium filter, shown in column 3. Column 4 shows the mean values of the ratios of ionization currents measured with the experimental chamber to those measured with the standard chamber. Column 1 contains the number of separate ratio determinations from which the mean values were computed. These determinations were made on different days and with different adjustments of many parts of the apparatus. Most of the individual values are within 1 per cent of the mean value. In no case does the difference exceed 2 per cent.

TABLE I

1	2	3	4
5	95	5	1.01
4	95	4	.99
4	95	3	1.01
4	80	4	1.00
4	80	3	1.01
4	80	2	1.01
3	70	3	1.00
4	60	3	.98
4	60	2	.99
4	60	1	1.01
3	50	2	.99
4	40	2	.99
5	40	1	.99
6	40	0	1.00
6	35	0	1.02
15	30	1	1.02
3	30	0	1.01
8	25	0	1.00
4	20	½	1.00
5	20	0	1.01

The various numbers in column 4 differ from their mean value, 1.00, by not more than 2 per cent. The variations may result from experimental error, since they are small and not systematic. It should be noted, however, that the constancy of these values for the unfiltered rays at 20, 25, 30, and 35 kv. is accidental, since these very soft rays are absorbed to a considerable extent in the walls and central electrode of the experimental chamber. On the basis of some experiments on the

[1] Kroenig and Friedrich (p. 445) used a first aperture 5 mm. in diameter with the standard chamber. The aperture used with the experimental chamber is not recorded, but a consideration of other data given shows that it must have been larger.

absorption of these rays by a thin sheet of bakelite, it is estimated that the reduction of intensity within the chamber from this cause should amount to 8 or 10 per cent. It must be assumed, therefore, that the ratio of the ionization current to the energy absorbed by the air in the chamber is greater for soft rays than for hard rays, and that in the case of this particular chamber the difference is compensated by absorption in the walls.

In these experiments, the standard-chamber measurements are made on .327 c.c. of air. The ratio of the volume of air in the experimental chamber to this volume is 1.38. A comparison of the mean value, 1.00, of the ratios in column 4 with this ratio, 1.38, shows that the ionization of the air in the experimental chamber is about 28 per cent less than it would be if the chamber walls were replaced by air of great extent.

With hard rays, the diminution of intensity within the chamber by absorption in the walls is negligible, and geometrical considerations show that rays scattered by the walls would be more intense inside the chamber than those scattered by surrounding air if the walls were replaced by air of great extent, and that they tend to augment the discrepancy of 28 per cent mentioned above rather than to diminish it. It is indicated, therefore, that that part of the influence of the walls which may be attributed to a lack of equilibrium between the energies of electrons absorbed and emitted by the inner thin surface-layer of the chamber wall, amounts to at least 28 per cent for hard rays and, as shown above, to somewhat less for soft rays.

THE EFFECT OF THE ANGLE OF INCIDENCE OF THE RAYS ON IONIZATION CURRENTS MEASURED WITH THE EXPERIMENTAL CHAMBER

The results of experiments on the effect of varying the angle of incidence are embodied in the curves of Figure 4, in which the radii vectores represent the relative values of the currents at the various angles. The curves show that the chamber may be used without correction for direct radiation at an angle of incidence differing considerably from 90°. They show also that measurements made on scattered rays, which we may assume to be uniformly distributed in direction, will be too low in value. By an approximate method of integration, the correction factors were found to be 1.01 for the 95-kv. rays, 1.02 for the 40-kv. rays, and 1.06 for the 20-kv. rays. Since the radiation in tissue is mostly direct when soft rays are used, it is obvious that for this kind of work the factors may be neglected.

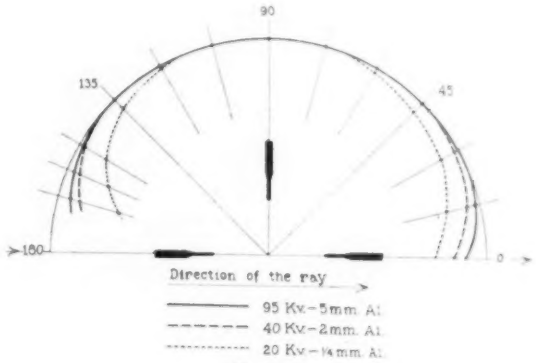

FIG. 4.

SUMMARY

Within a limit of error of about 2 per cent, the particular chamber studied functions independently of wave-length, over the range employed, for angles of incidence of a direct ray within a considerable range in the neighborhood of 90°. With proper orientation, it should integrate direct and scattered radiation without appreciable error under the conditions encountered in dosage experiments. It is equivalent to .326 c.c. of air, which is about 28 per cent less than the actual volume of its enclosed air.

It is shown that the walls and other parts of chambers of this kind may have a considerable influence on the rate of ionization of the enclosed air. That part of the influence which consists in a diminution of the intensity of radiation inside the chamber by absorption and scattering in the walls depends both on the nature and thickness of the walls and on wave-length. The constancy and magnitude of the total influence in the case of the chamber studied shows that that part of the influ-

ence which has to do with emission and absorption of electrons by the inner thin surface-layer of the chamber may be considerable and not independent of wave-length. It is indicated that the variation with wave-length is of such amount and in such a direction that it may be compensated approximately by absorption in a properly designed chamber.

The necessity of experimental calibration of a chamber to be used for dosage work is pointed out and the more important sources of error in comparison experiments are discussed.

CONSIDERATION OF ASSUMED CAUSES OF ROENTGEN-RAY INTOXICATION AND INJURIES

BY B. F. SCHREINER, M.D., F.A.C.S., AND K. W. STENSTRÖM, PH.D.

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BUFFALO, NEW YORK

THIS paper is deemed necessary in view of the numerous scattered contributions to the literature which deal with important phases in the development of radiation therapy. In this form of therapy the methods used require a working knowledge of physics and a good pathological and clinical experience in order to avoid the known dangers to the patient.

RADIATION SICKNESS

It is a common experience that patients become sick on the treatment table or immediately afterward. Nausea, vomiting, headache, and malaise are almost constant symptoms no matter what part of the body is radiated, so long as the dose is large. Occasionally there may be a slight rise in temperature. The following reasons have been advanced as causative factors in this so-called radiation sickness:

1. Gases produced by high voltage roentgen rays (ozone, nitric acid fumes, etc.).
2. An electric field surrounding the patient.
3. Chemical changes which can be estimated.
4. General influences on the body (body dose).
5. Radiation of certain glands of internal secretion.
6. Nervous strain and psychic influences on the patient.
7. Destruction of intestinal mucosa (Warren & Whipple).

There is no doubt that several of these factors cooperate in causing radiation sickness.

1. *Gases Produced by High Voltage.* The different gases produced will certainly nauseate anybody if they are not removed from the room, but with good ventilation (a necessary condition for deep therapy), not enough is left to account for the sickness.

2. *An Electric Field Surrounding the Patient.* If the tube and aerial are shielded from the patient with grounded metal, he will not be in an electric field but nevertheless the experience has been in various places where they are carrying out the shielding and grounding of the patient, that radiation sickness is still prominent.

Factors 1 and 2 can certainly not be the cause of radiation sickness when a radium pack is used, but it is our experience that patients subjected to large radium packs will suffer from radiation sickness.

3. *Chemical Changes Which Can Be Estimated.* Work done by Dr. Carl Cori of this Institute, and others, shows that the nitrogen output is increased immediately after radiation. However the roentgen-ray sickness has been found not proportionate to this change.[1]

4. *General Influences on the Body.* Changes in the cells must take place inside the body wherever rays are absorbed. It seems quite probable that this disturbance will affect the system. The sickness ought therefore to be approximately proportional to the "total body dose," if other conditions are the same. By "body dose" we mean the total amount of roentgen-ray energy absorbed by the whole body. In calculating this dose we are using an arbitrary unit designated "Ax" which has

been defined and discussed in another paper.[2] The sickness can not be accurately graded, but a rough estimation can be made. We have treated about one thousand patients with penetrating roentgen rays (200 kv.) and are under the impression that this ratio between body dose and roentgen-ray sickness holds good. (See also under 6.)

5. *Radiation of Certain Glands of Internal Secretion.* The adrenals are very sensitive to radiation and several cases have been reported in the literature where death has been caused by radiation of these organs. Apparently a small dose over the adrenals will cause nausea and it is probable that they are sensitive enough to react against an appreciable amount of scattered rays.

It is a common experience in radiation of the ovaries in the treatment of fibroid in which about 30 to 35 per cent of the erythema skindose is used inside the ovaries that these patients also suffer from some nausea and at times vomiting. It seems highly probable that this is due to the influence exerted on ovarian tissue. Some of the other glands of internal secretion as the thyroid may also have an influence when exposed to radiation.

6. *Nervous Strain and Psychic Influences on the Patient.* The psychic and nervous influences play without doubt some part in the production of so-called radiation sickness, as it has been our observation that certain individuals who are very nervous or high-strung are more sick than robust people. Apparently the maintaining of certain fixed positions over a long period of time, causing nervous strain, and the covering with lead rubber for protective purposes, gives them the sensation of restraint which is exaggerated by suggestion either verbally or by putting basins beside them and telling them if nauseated not to move but to use these basins.

When we began treatment with penetrating roentgen rays in 1921 we used a current of 200 kv., and 2 ma., since then we have slowly increased the current up to 8 ma. per tube. For certain cases we now use two or even three tubes simultaneously. The result of the reduced treatment time is that very few patients become sick on the treatment table, and the length of sickness after treatment is markedly reduced.[3] This is especially noted if previous to radiation the patient has had active elimination, emptying the intestinal tract, and has partaken freely of fluids and alkaline drinks. It is customary after the radiation of these patients to give them 1,000 c.c. normal salt solution or bicarbonate of soda 2 per cent, per rectum.

7. *Destruction of Intestinal Mucosa.* Warren and Whipple[4] claim that roentgen-ray sickness is due mainly to the destruction of intestinal mucosa. At the same time they state that such destruction takes place only if the intestines are in the roentgen-ray field. Scattered rays from other parts of the body have no such effect. Then it is evident that the destruction of intestinal mucosa can not be the explanation of roentgen-ray sickness when for instance breasts are radiated. Still roentgen-ray sickness is just as common in such cases (contrary to the experience of Warren and Whipple in raying dogs' chests with standard doses of roentgen ray).

MODERN ROENTGEN-RAY DOSAGE

In the literature there are numerous case reports of injuries to intestines by hard radiation. This is not to be wondered at for it is essential in deep therapy work to calibrate machines and to use radiation charts deduced from this standardization and to figure out what percentage of an erythema dose is produced in different parts of the body, a thing which has been sadly neglected. Much experimentation has been done, especially in Germany, to show how much of a roentgen-ray dose the different organs will stand. It is evident that the dose in a certain organ should be kept below the dose which will cause destruction. It has been stated by several writers that intestines will tolerate 130 to 140 per cent of the skin erythema dose without showing any destructive changes, except in Peyer's patches.[5] It may be that the cases Warren and Whipple refer to did receive more than 130 per cent of the skin dose in some part of the intestines. As far as we can judge from the incomplete data,

the case of Rehfisch must have received an overdose; 700 ma. min., at 50 cm. distance with 1 mm. Cu. and 200 kv. seems to be high for an erythema skin dose. The radium dose of 2200 mc. hrs. seems rather large and an addition of 1776 mc. hrs. after nineteen days is undoubtedly too much in combination with roentgen rays. The field also is unusually large (30 cm. diameter). If the diameter of the abdomen is about 20 cm., then we consider that 90 per cent of an erythema skin dose given over one anterior and one posterior field, each 20 × 20 cm. (60 to 80 cm. distance, ½ mm. Cu., 200 kv.) plus 2000 mc. hrs. of radium emanation filtered through 2 mm. of brass would have been a satisfactory dose. The dogs receiving the human erythema dose over seven large fields on the abdomen, as in certain experiments by Warren and Whipple, will certainly receive too much of a dose in the intestines. Even with one and a half erythema dose on one field they still will get up to 140 per cent in some parts of the intestines.

ROENTGEN-RAY IRRADIATION AND INJURIES

With roentgen rays produced at 200 kv. it is easy to get a destructive dose into almost any part of the body without injuring the skin. Lymphocytes are very sensitive to radiation and a leucopenia can be produced with a fraction of a skin dose if it is given over a large field. About one-third of an erythema dose inside the ovaries is enough to sterilize. The adrenals are very sensitive organs. Extreme care should be taken to avoid exposure of these glands. It is an important question whether the case reported by Rehfisch received a considerable roentgen-ray dose in the adrenals or not, and the same question must be made concerning the dogs referred to.

Even in the best clinics in the world under strict supervision of the routine in the carrying out of these treatments it is possible, through errors in technique, for instance, leaving out a filter or miscalculating the time of exposure, to produce very severe injuries both externally and internally. There has been little said in the literature in regard to the injuries caused indirectly in the treatment of cancer of the uterus which may be associated with a latent gonococcus infection. There is no doubt that doses of roentgen ray, over 40 per cent, may stir up a chronic salpingitis with the production of a pelvic peritonitis, and may even cause death. Cases are known in which this occurred without any intrauterine manipulation for the insertion of radium, so that it is possible that this injury was the result of external radiation.

COMPARISON BETWEEN ANIMALS AND HUMANS

It is now a well-known fact that the skin of a number of animals, probably most of them, can stand several times the amount of roentgen rays that human skin can stand. This may be due to the fact that animal skin is an entirely different organ than human skin. Kok and Vorländer define an erythema for mice thus—"the hair should come out at a slight pull." They find then that the erythema dose for mice is one and one-half to two times the human erythema dose. Dr. Gerty Cori of our Institute considers this dose an arbitrary one as "a slight pull" is something variable. She prefers to let the hair fall off spontaneously while the color of the skin does not change (4 ma., 95 kv., 23 cm. distance, 2.5 mm. Al. filter, 50 to 60 min.). Then the depilatory dose for mice is raised to about five to six times the human erythema dose. Warren and Whipple state that the erythema dose for dogs is one and one-half times the erythema skin dose for man. It can not be assumed that the internal organs of man and different animals show the same relative sensitivity as the skin; for instance, the intestines of mice are five to six times less sensitive than that of man. We therefore propose that the dose given to the organs of animals should be measured in percentage of human erythema skin dose. In certain experiments Warren and Whipple gave the human erythema skin dose over seven large fields on the abdomen of dogs with fulminating symptoms which led to the death of the animals in four days. We estimate that these dogs must have received two to three times the human erythema dose

inside the intestines, and the destruction they speak of is a natural sequence.

CONCLUSIONS

1. Experimental data obtained from animals which were subjected to roentgen-ray treatments without record of percentage depth dose are of little value in radiation therapy.

2. So-called radiation sickness is not explained on the basis of injury to intestinal epithelium alone.

3. The amount of roentgen ray absorbed in the body can be used as a clinical guide in these sicknesses, unless certain glands are radiated.

4. External radiation in large dosages may, and often does, stir up latent salpingitis.

5. It is absolutely essential to work with standardized roentgen-ray machines and roentgen-ray charts showing the distribution of energy.

6. From our experience with 1000 cases treated with high voltage roentgen ray, if these factors (as above) are adhered to, the unpleasant symptoms, with the exception of headache, nausea and vomiting, are rare.

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A CASE OF PAPILLARY OVARIAN CYST TREATED BY ROENTGEN RAY

BY C. P. LAPE, M.D.

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THE roentgen-ray treatment of ovarian cysts is mentioned very little in the literature. It may be because they are considered purely surgical, or that they do not occur very frequently. However, one case of papillary ovarian cyst in my experience seems interesting enough to report.

Ewing gives a very comprehensive description of the varieties of ovarian cysts from a pathological and histological viewpoint. He classifies cysts as papillary adenomas, of either the serous or pseudo-mucinous type, with many mixed and transitional varieties.

Lynch and Maxwell use Pfannenstiel's classification, placing papillary cysts under the serous branch of cystadenomas, with cystadenomas as a type of epithelial new formation. They say these tumors are on the border line of malignancy and quote Pfannenstiel, who claims that 50 per cent of these cases are really malignant. All observers seem to agree that they are of epithelial origin, that they are often malignant either from beginning or by implantation metastases and that they do not metastasize through the blood or lymph streams.

Most of the few references to radiation treatment which I have found have been mentioned under the use of radium. In a summary of a report in the London Radium Institute, Mr. A. E. Hayward Pinch gives cysts in the class for which radium is useless and later mentions roentgen ray as preferable for some conditions, among them, cystic diseases of the ovary. The following is quoted from his report under the heading "cysts." "With regard to cystic conditions in general, radium treatment is of little value, more especially if the cyst be large and tense. When favorably situated, however, removal of the contents of the cyst by incision or aspiration, followed by the introduction of radium into the cyst cavity, may be utilized to induce inflammatory adhesions of the cyst walls and so prevent its reappearance."

Dr. Stacy in discussing the treatment of non-malignant tumors of the pelvis gives ovarian tumors as a contraindication to

radium treatment. There was no explanation of this statement, and so ovarian cysts might or might not have been included.

Dr. Scott says in a paper on hemorrhages from the non-pregnant uterus in the absence of neoplasms, "Certain ovarian conditions, such as lutein cysts, are commonly associated with both bleeding and glandular hyperplasia of the endometrium. Finally, the condition can be cured by roentgen-ray or radium therapy and the action of these substances is primarily on the ovaries."

Most surgeons and gynecologists advise postoperative roentgen-ray treatment for malignant conditions of the ovaries.

The case under consideration was referred by Dr. George T. Moseley, after operation, with the following history: An unmarried woman, aged twenty-five, no history of pelvic infection. The patient was first seen in May, 1921, by Dr. Moseley, when she had a tumor in the abdomen about the size of a grapefruit, which was diagnosed ovarian cyst. Operation was advised. Within a few weeks the tumor enlarged rapidly to midway between the umbilicus and the ensiform. Operation was then performed. A large cyst with one compartment was found. It apparently arose from the left ovary but at the time of the operation there was a papillary infiltration into the tube, broad ligament, uterus and intestine. There was no ascites. It was evidently a typical papillomatous cyst, with escape of cells and development of papillae which were friable and markedly congested. The sac proper was emptied and removed but the base could not be removed. She was referred for roentgen treatment six days after operation with a hard mass in the abdomen extending well above the umbilicus, which increased in size for a time. There was moderate anemia present. The condition was considered rather hopeless as it had all the signs of a rapidly progressing, malignant, papillary cyst.

Nothing more, surgically, could be done, so the patient was given roentgen-ray treatments. The family and patient were told that radiotherapy would probably produce a permanent menopause but that it might help the condition. The patient was treated with 110,000 volts by sphere gap reading; 5 ma. 12 in. skin target distance, 3 mm. Al. filter, 10 min. exposure over each one of several areas covering lower abdomen from front, back and sides. The treatment was pushed during the first month after which she was given one series a month for nine months, and then every two months for two series. The mass in the abdomen grew softer at first and then gradually and progressively smaller until it entirely disappeared. The patient's general condition improved until, at present, she seems perfectly well. A report from Dr. Moseley at the time of writing, February 17, 1923, shows the patient still free from symptoms and clinically well.

Of course, there could be some questions raised but I believe the roentgen-ray treatment had a distinct beneficial effect on the condition. Whether it was malignant or not, it was inoperable, and disappeared under roentgenotherapy.

NOTE. Apr. 8, 1924. The patient is still clinically well.

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Information of interest to all readers will be found on page vii. Lists of officers of The American Roentgen Ray Society and The American Radium Society will be found on page preceding Editorial Section.

PARK P. BRENNEMAN, M.D.

[October 15, 1859–March 22, 1924

Dr. Park P. Brenneman, for many years a member of the American Roentgen Ray Society, died in his office in Lancaster, Pennsylvania, on Sunday, March 23, 1924, while seated at his desk talking with a patient. Dr. Brenneman had been afflicted with a cardiac lesion for several years and had been in poorer health than usual since his return from the recent Atlantic City meeting. He was, however, able to attend to his practice until the day of his death.

Born at Strasburg, Pennsylvania, October 15, 1859, Dr. Brenneman gained his preparatory education at the Millersville State Normal School, and received his medical degree from the University of Pennsylvania in 1884. For nine years after his graduation he practiced his profession in Sidney, Australia. During this period he made a notable collection of animals and birds which is still attractively displayed in his office. After his return to America he engaged in general practice in Lancaster, but he became interested in roentgen rays soon after their discovery, and was the first physician to practice roentgenology in Lancaster.

At the time of his death he was roentgenologist and electrotherapist to the Lancaster General Hospital and St. Joseph's Hospital. He was a member of the American Medical Association; he was for twenty years secretary of the Lancaster County Medical Society and later its president. Dr. Brenneman was a member of Orient Lodge Number 110 F.A.M., New South Wales, and of numerous local societies and clubs. Naturally modest and retiring, he was yet possessed of a personality at once so kindly and genial as to endear him to all who had the opportunity of knowing him.

PARK P. BRENNEMAN, M.D.
[1859–1924]

He was married in 1908 to Mildred Eckert Sutton, who survives him.

D. R. BOWEN.

THE STATUS OF RADIATION THERAPY IN CANCER OF THE TONGUE AND FAUCES

It is unfortunate for mankind that the medical profession exhibits one of its greatest weaknesses in its inability to establish a certain and permanent cure for cancer. Early recognition and immediate complete eradication by surgery or otherwise are our only hopes at present. Complete removal is never certain in the dangerous localities. Some progress has been made toward early recognition by propaganda among the laity and by medical training, but no one knows better than the radiologist, who sees most of the advanced cases, that there is much work yet to be done in the teaching of both groups. The neglect of a sore in the mouth that has refused to heal quickly, rectal bleeding ascribed to hemorrhoids without a digital examination higher up and failure to search for the cause of intermenstrual bleeding toward the menopause or recurrence of bleeding afterwards still cause a host of patients to be brought to us with well-advanced cancer.

As radiologists we all realize our conscientious duty to care for many hopeless wrecks to the best of our individual abilities with the resources at our command, but we yearn for a better education of laity and profession toward a general early recognition of malignancy. We have become generally cognizant of the fact that the more often cancer, in many localities, is discovered at a distinctly operable stage, the more certain are the non-surgical measures of radiation and electrodesiccation to succeed. In many instances, such as cancer of the cervix uteri, mouth and tongue, radiation methods, properly employed, are just as efficacious in early cases as surgery. If we are correct in assuming this from reliable statistics, it seems no more than just that we should claim some share of certainties along with the distressing palliative or hopeless cases that are to a certain extent thrust upon us.

Surgery alone in cancer of the tongue and tonsil cannot be regarded as a very great success except in very early cases and in the hands of a few. The non-surgical measures of radiation and electrodesiccation seem to be better adapted to dealing with these lesions, and probably the majority of early cases go to the radiologist along with the more advanced ones, at least in certain geographic localities. In both the tongue and tonsil radium is our most important therapeutic agent because of its peculiar adaptability to different methods of application. Electrocoagulation is likely to be necessary as an adjunct in many instances, and as cervical metastases are inevitable and usually early, the roentgen ray is indispensable.

Carcinoma of the tonsil yields surprisingly good results and the prognosis is far better than in the neighboring structure, the tongue. The anterior pillar forms a peculiar dividing line between hopeful and hopeless lesions of equal size. Surface applications to the tonsillar region are best made by means of a modified tonsil clamp holder or similar device, and implantation of element or emanation needles or bare emanation tubes are very frequently required in addition. Electrodesiccation may also be indicated in some instances, but in the use of this and implantations, the classic anatomic danger must not be overlooked. Even the cervical gland metastases from tonsillar carcinoma respond, as a rule, more favorably to external radiation than do those from the tongue, although the pathological appearance in the cancer cells may differ little or not at all.

In cancer of the tongue the prognosis depends upon the exact location as well as the extent and duration. The less frequent lesions on the tip yield the best ultimate results, and in the absence of metastasis, our non-surgical measures are probably no better than complete wide surgical removal, except possibly in the conservation of tissue.

Success in the treatment of lesions on the side of the tongue, the usual location, will depend largely upon the extent and duration of the growth and the thoroughness of treatment. Metastasis usually occurs early, and implies difficulty in rendering all involved structures accessible to adequate treatment. Except in comparatively early lesions without cervical metastasis these cases are usually regarded as unfavor-

able ones for surgery and we find non-surgical procedures displacing surgery generally in proportion to the extent of the growth. It can be conservatively stated as a fact, however, that radiation and electrodesiccation give better results, the earlier and the less extensive the lesion, and probably equal those of surgery at any period. Many radium therapists prefer to make a preliminary surface application of radium over and around the involved area in all cases, and in superficial early lesions this may suffice. In most instances, however, implantations by needles or bare emanation tubes are required in addition. We must recognize the fact that this procedure implies a certain amount of surgical trauma which may or may not tend to promote metastasis. Some radium therapists believe that a preliminary surface application offers some protective influence against this; which is, however, open to question. One should also consider the possibility of dislodging cell emboli by infiltration anesthesia. There is ground for discussion as to the relative merits of bare tubes and needles. The former are certain to create definite though small areas of necrosis, which may probably be disregarded when the implants are made entirely in malignant tissue which is expected to slough away, but to be entirely effectual, some of the seeds must be implanted in more or less normal tissue in order to catch the outlying malignant cells. The resulting necrotic areas in normal tissues promote dense localized cicatrices with rather poor vitality, which do not offer much resistance against recurrences. Moreover, this dense scar tissue frequently causes pain afterwards. Needles, on the other hand, may not give so even a distribution of radiation, and, aside from the greater difficulties of manipulation, their introduction probably produces more trauma.

Electrodesiccation plays a very important part in the treatment of a large number of these cases. There is at present considerable difference of opinion as to the best time for its employment. It may take the place of surface radiation; it may precede or immediately follow implantation or it may be done at or near the height of the reaction, at which time it tends materially to lessen the discomfort from the reaction. If biological studies are of any service to us, the combined effect of the heat plus that of radiation upon cells not directly and completely destroyed by either alone is ideal, and the two procedures should be timed to derive this benefit to best advantage.

There is good reason for believing that severe radium reactions may, in certain instances, tend to promote metastases. The intense inflammatory reactions may widen up lymphatic channels, and malignant cells which have not received a lethal dose may have easier paths through which to spread before the time when the secondary fibrosing effect of the radiation or the closing of lymph channels block them off. This undoubtedly has occurred, and early electrodesiccation may tend to prevent it.

There is always the chance of severe secondary hemorrhage following extensive electrodesiccation, especially when the slough comes away. Ligation is not always sure to prevent this. Moreover, ligation in the presence of metastatic neck glands without an accompanying complete block dissection is often a very bad surgical procedure.

The careful removal of sections of tissue for biopsy is to be encouraged, provided it can be done with safety. Preliminary radiation does not destroy the identity of cancer cells, and may offer a protection against metastasis.

All of these possible variations in technique deserve the most careful consideration, and the biologist and pathologist should be urged to assist us in determining the very best sequences of procedures which will be for the best good of our patients.

When cancer occurs in the tongue back of the anterior faucial pillar it becomes a far more serious problem, especially if it is extensive. The nearer it approaches the epiglottis the more grave is the prognosis, mainly because of the added difficulties of attacking the lesion throughout its entire extent.

The treatment of possible or evident metastatic cervical lymphadenoma is equally as important as that of the primary

lesion. It is almost the consensus of opinion that palpable neck glands should be treated thoroughly by roentgen rays or by gamma radiation. If they do not respond, two courses are open: thorough block dissection, provided the case is still operable, or the implantation of radium needles or bare tubes. Implantation of bare tubes is certain to promote the formation of very much devitalized cicatricial tissue which is easily and rapidly infiltrated by any recurrence.

Following radiation and electrodesiccation of mouth cases, the secondary or adjunct treatment is most important, though sometimes neglected. Bad teeth should be removed or otherwise adequately cared for, mouth cleanliness should receive the most careful attention and sloughs should be cut away as rapidly as is safe. The feeding of the patient is most important. There is no time when food of proper caloric value is more needed, and mouth feeding is exceedingly difficult in cases of extensive tongue or tonsil cancer. The duodenal tube may be necessary in some instances, and there may be cases in which a prolonged and exceedingly painful convalescence will indicate a preliminary gastrostomy.

HENRY K. PANCOAST.

COOPERATION

An ex-president of The American Roentgen Ray Society recently spoke before several hundred New York physicians on "Acute and Chronic Intestinal Obstruction." He made the point clear that the roentgen ray offers a very definite accessory to other means of diagnosis and that it is especially valuable in *localizing* abdominal lesions. He also emphasized the point that no operation should be performed without first making a roentgen examination for purposes of definite localization. These points were modestly submitted and in no sense was the lecturer's stand to be interpreted as making a special plea for the roentgen method to the detriment or exclusion of other means of diagnosis. He was particularly clear and fair in his attitude, and it seemed to most hearers that he had emphasized in the strongest possible manner that the value of the roentgen ray for diagnosis exists in its use in conjunction with all other known means.

When the time came for discussion, a prominent surgeon took the floor and began with the statement that he belonged to "the old-fashioned school of surgeons" and that he could make a complete diagnosis by the old methods. He stated bluntly that the roentgen ray was neither desirable nor to be relied upon, though he gave the lecturer full credit for his sincerity and praised what he called his "unusual ability in diagnosing from the *x*-ray." He maintained firmly, however, his own attitude regarding the position of the roentgen ray and used the argument that operations were often unnecessarily delayed by a roentgen examination to the detriment of the patient.

Here would seem to be well illustrated one of the fundamental difficulties between the roentgenologist of today and his fellow practitioners. Unfortunately, roentgenologists cannot be considered entirely blameless in the matter. Too many specialists are apt to claim perfection for their own speciality to the exclusion of everything else. This attitude is out of keeping with the stand taken by leading roentgenologists and creates dissatisfaction on the part of the medical profession at large, not only with roentgenologists but with roentgenology. Our specialty is one of the youngest departments of the science and art of medicine and would seem to have reached the stage already passed by other branches where it needs to be saved from its friends.

There was a time, not so many years ago, when the roentgenologist was of necessity a propagandist. It is the fate of youth to be on the defensive, and it is no reflection on our specialty that physicians insisted upon "being shown" instead of blindly accepting our word. We have now, however, at our command the results of more than twenty-five years' experience and an accumulated mass of scientific data that places roentgenology upon a foundation so secure that the voice of the propagandist is no longer needed. The accomplishments of the past in our field speak for themselves. We have now reached a time when one of our chief needs is a sane evaluation of the data we have amassed. There is nothing at

all to be gained by claiming infallibility for the roentgen ray, or by claiming that its use renders it advisable to discard other true and tried means of diagnosis and treatment. Rather is much harm to be done by such claims. We have a strong conviction that a liberal attitude toward our confreres in other lines of medical work and a conservative estimate of the possibilities of our own method, together with a thorough knowledge of its limitations, are the safe starting points for the progress of roentgenology.

The true scientific spirit is impersonal, and those who have it are willing to give credit wherever it is due, and to sacrifice their own convictions, however much it may hurt, in the interests of the truth.

The valuable contributions of roentgenology to medical science will be much more readily accepted by physicians and surgeons if the roentgenologist adopts an attitude of tolerance toward all who do not yet believe as he does. The only reliable and permanent cure for lack of confidence in roentgenology is that most conventional instrument of the twentieth century—education.

RADIUM THERAPY

We wish to call to the attention of our readers the Radium Report of the Memorial Hospital, Second Series, 1923.[1] A review of this work will be published in an early issue of the Journal; however, its importance to radium therapists warrants a preliminary notice. The report consists of numerous articles by various members of the staff of the Memorial Hospital. The main object of the entire report is well summarized in the early paragraphs of the first article, as follows: "During the past four years, well-supported conclusions regarding the method of choice for different lesions and regarding safe and efficient dosage have been reached. In other words, standards for treatment have been established which are reliable and are possibly a close approach to the best. Moreover, a knowledge of what can be accomplished by radium in the various forms and stages of malignant growths has been acquired, so that a very accurate prognosis can now be given at the outset of treatment. This knowledge was not acquired sufficiently early for its incorporation in the present publication in the form of records of apparently complete retrogressions. The period covered by this report, like that of the preceding one, has been a period of growth; an attempt to discover just what radium is able to accomplish in the cure of cancer; a period of development of methods and dosage; of determining what forms of cancer can be benefited by radium, and to what extent."

The extensive experience of the members of the staff of this hospital in the treatment of malignant disease and their painstaking interpretation of results warrant a careful study of every article in the report. There is nothing in the book, however, that will be read with greater interest and profit than the Mutter Lecture by James Ewing on "An Analysis of Radiation Therapy in Cancer." This lecture was presented eighteen months ago, and at that time some of its conclusions seemed rather radical; but experience since then has served to justify practically all of them. A short quotation from this lecture is given on page 410. This is only one of many significant and illuminating statements found throughout the lecture.

[1] Paul B. Hoeber, Inc., New York.

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SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this column solicited promptly after the events to which they refer.

AMERICAN RADIUM SOCIETY

NINTH ANNUAL MEETING

The Ninth Annual Meeting of the American Radium Society will be held at the Hotel Drake, Chicago, Illinois, on Monday and Tuesday, June 9 and 10, 1924. This is immediately following the Radiological Society's scientific sessions but preceding the meeting of the American Medical Association with Section on Radiology.

The following is a preliminary program of the American Radium Society meeting which includes subjects of vital scientific interest to every member of the Society, and none should fail to attend.

In addition to the Tuesday afternoon clinics conducted at the Mercy Hospital amphitheater, the Local Committee has been successful in completing the final arrangements for a most interesting Monday evening banquet at which addresses will be presented by Dr. James T. Case, President, Professor Regaud of Paris, Dr. Howard Kelly of Baltimore, and Dr. James Ewing of New York. The subject of Dr. Regaud's address will be "Biologic Aspects of Radiotherapy"; the subject of Dr. Kelly's address will be "That which is Assured in Radium Therapy"; Dr. Ewing will speak on "The Present Status of Radiotherapy."

Since all the scientific sessions will be held at the Hotel Drake it would be advisable to make reservations for accommodations immediately.

Members of the American Medical Association interested in radium therapy are cordially invited to attend both the scientific and clinical sessions.

PRELIMINARY PROGRAM

SCHMIDT, DR. WILLIAM H., Philadelphia, Pa. "Indications for the Use of Radium and other Methods in the Treatment of Cancer."

SCHREINER, DR. BERNARD F., Buffalo, N. Y. "Results Obtained by Radiation Therapy at the New York State Institute for the Study of Malignant Disease."

NEW, DR. GORDON B., and FIGI, DR. F. A., Rochester, Minn. "Treatment of Fibroma of the Nasopharynx."

PANCOAST, DR. HENRY K., Philadelphia, Pa. "Some Observations on the Treatment of Carcinoma of the Larynx."

GRIER, DR. G. W., Pittsburgh, Pa. "Treatment of Malignant Disease in the Mouth."

SIMPSON, DR. AUGUSTUS, Washington, D. C. "Radium in the Treatment of Tonsils."

POMEROY, DR. L. A., and MILWARD, DR. FRANK, Cleveland, Ohio. "The Use of Radium in the Treatment of the Female Urethra."

YOUNG, DR. HUGH H., Baltimore, Md. "Survey of Results Obtained with Radium in Carcinoma of the Prostate and Bladder."

SOILAND, DR. ALBERT, Los Angeles, Calif. "The Treatment of Inoperable Cancer of the Pelvis by Radium."

BENSON, DR. F. C. "Simple Enlargement of the Prostate."

SAMUEL, DR. ERNEST C., New Orleans, La. "Radiation in the Treatment of Carcinoma of the Uterus."

FAILLA, DR. G., New York City. "A Brief Analysis of some Important Factors in the Biological Action of Radiation."

CLARK, DR. WM. L., MORGAN, DR. J. DOUGLAS, and ASNIS, DR. EUGENE J., Philadelphia, Pa. "Objections to the Use of Radium Emanation in Bare Tubes, with Clinical and Histological Observations."

LEE, DR. BURTON J., New York City. "Technique and Results in the Treatment of Mammary Cancer by Radiation."

Demonstrations of clinical results and technique will be given at the Mercy Hospital amphitheater on Tuesday afternoon by the following Fellows from Chicago:

BECK, DR. EMIL G. "Carcinoma of the Jaw and Cheek."

HANFORD, DR. CHAS. W. "Carcinoma of the Esophagus."

KRETSCHMER, DR. H. L. "Treatment of Carcinoma of Prostate with Radium."

SIMPSON, DR. FRANK E. "Cancer of the Tongue."

BUNDY, DR. HARRY E. "Benign Hemorrhage of the Uterus."

SCHMITZ, DR. HENRY. "Carcinoma of the Breast."

JOINT MEETING

The Western Section of The American Roentgen Ray Society will hold a joint meeting with the Pacific Coast *X*-Ray Society in Seattle and at Mt. Rainier, July 21–24, 1924. A detailed announcement of the meeting and program will be made in the next issue of the Journal.

THE FIFTH ITALIAN CONGRESS OF MEDICAL RADIOLOGY

THE Italian Society of Medical Radiology holds meetings of national scope every eighteen months. The organization of such a meeting is somewhat different from those of American societies and it may be well to give a few details. The

Congress, as it is called, has an honorary president, a president, a vice-president, and a secretary separate and distinct from the corresponding officers of the society. With the exception of the honorary president, these officers are chosen from the leading radiologists of the city in which the congress is to be held, or its vicinity. There are, in addition, an honorary committee and an executive committee. The former is composed of prominent citizens of the locality, such as senators, representatives, bank presidents, newspaper directors, army officers, professional men, etc. The executive committee is chosen from members of the society.

The Fifth Congress was held in Palermo, October 18 to 21, 1923. The honorary president was His Excellency Corbino, Minister of National Economy, who happens to be an eminent physicist, interested in radiology. The president was Dr. G. Scaduto, the vice-president, Dr. G. Arnone, and the secretary, Dr. S. Sgroi. The presidents of the honorary committee were the Mayor of Palermo and the Prefect of the Province. These details are given simply to show the official recognition which medical radiology receives in Italy. In this connection we may add that a reception was given to the members of the society and guests by the mayor at City Hall.

The congress was very well attended—more than five hundred taking part in it, directly or indirectly. A few foreigners were also present. Among these was Dr. Heuser, of Buenos Aires, who had previously attended the Chicago meeting of the American Roentgen Ray Society.

About 150 papers were on the scientific program. Naturally most of these were not read, in spite of the fact that the meeting lasted four days. More than one-half of the papers were on roentgen-ray diagnosis, very few on radium therapy. There were several papers on the biological effects of radiation, and on technical developments. The society had asked a few prominent members to prepare special reports on definite topics and a good deal of time was allowed for their presentation and discussion. The titles were "Pneumoradiography," by Dr. M. Gortan, of Trieste; "Radiodiagnosis of the Urinary Tract," by Dr. G. Boidi Trotti of Turin; and "Roentgen Therapy of Cutaneous Diseases," by Dr. A. Rossi, of Parma.

The writer, being a physicist, cannot give a competent résumé of the medical papers. It seems, however, that as regards therapy, the general trend is towards the administration of divided doses, adjusted according to the requirements of the individual patient. The massive treatment idea, sponsored by the Erlangen school, seems to have fallen into disfavor. Incidentally it might be added that the same feeling exists in other parts of Europe, including Germany. The writer, however, did not visit Erlangen.

It may be of interest to American radiologists to know that in Italy roentgen-rays are used, apparently with success, for the treatment of malaria in quinine-resistant patients. The enlarged spleen in such cases is irradiated with fairly small doses, as in America. The field of radiotherapy is constantly being extended, as shown by the titles of some of the papers on the program: "Results of *X*-Ray Treatment of Lethargic Encephalitis," by S. D'Arman; "Contribution to the Radiotherapy of Diseases of the Nervous System," by V. Podestà; "Radiotherapy in Tabes Dorsalis," by S. D'Arman; "Irradiation of the Spleen in Tuberculosis according to Dr. Manoukline's Method," by M. Gortan; "*X*-rays and Rabies (Considerations Relative to One Clinical Case)," by M. Pidone; "Roentgen Rays in Ophthalmology," by G. Villasevaglios; "Contribution to the *X*-Ray Treatment of Neoplastic Tuberculosis," by S. Migliorino.

The discussions in general were very interesting. From these one got the impression that Italian radiologists, as a rule, have a broad knowledge of the subject. Of particular interest was the discussion of Dr. Ghirlanducci's method of "variable filtration" in combination with ionophoresis for the treatment of certain types of cancer. Briefly the method is as follows: The tumor tissue is infiltrated with metallic ions electrolytically and *at the same time* *X*-radiation is applied in steps with increasing filtration. The purpose of ionophoresis, of course, is to increase the secondary radiation within the tumor. The advantage

of the "variable filtration" is not so evident. However, it is contended by the advocates of this method that larger *total* doses can be administered by starting with unfiltered rays and gradually increasing the filtration, than if a single filter is used. Another justification for this practice is based on the assumption that some cells in the tumor may react better to radiation of one wave length, while others may be more sensitive to rays of another wave length. Some of the reasons given do not appear strictly logical. In reality the subject requires more careful experimentation before any definite conclusions may be reached.

An important feature of the Congress was the large exhibit of roentgen-ray apparatus and accessories. All the Italian concerns were well represented. The most important German manufacturers had extensive exhibits. A Spanish concern had reserved a large space, but most of the apparatus did not arrive in time. Only one American roentgen-ray apparatus was exhibited.

On account of the high rate of exchange obtaining at present, Americans cannot meet European competition in this field. This is especially marked in the case of hot-cathode roentgen-ray tubes, which can be bought in Europe for a fraction of their cost here. However, at present European tubes have not the current carrying capacity of ours, but they will stand the same voltage. The usual milliamperage is 2.5, sometimes 4 as a maximum.

By visiting the exhibit one could form a very good idea of the present status of this art in Europe. In regard to deep therapy machines one could notice a trend towards the use of the closed-core, oil-immersed transformer, although machines with induction coils in air were present in considerable numbers. It is the impression of the writer that in general our machines are better, but some details have been worked out more fully in Europe. Considerable progress has been made in France and Italy as well as in Germany, in the problem of rectification by means of kenotrons. One machine shown in Palermo made use of kenotrons but no condensers were provided. While this scheme gives silent rectification with no moving parts, it suffers from the disadvantage that practically the whole voltage wave is utilized rather than the crest, resulting in unnecessary heating of the target. Condensers, however, may be added to this outfit so that a steady current is supplied to the tube always at the maximum voltage. Such a machine, operating at 200 kilovolts, is on the market in France. The writer saw one at the Physics Exhibit in the Grand Palais in Paris and was told that about twenty were either in actual operation or in the process of installation in France. One had just been installed at the Radium Institute. If this type of machine proves reliable in practice it will undoubtedly supersede the rotating switch apparatus.

In forming an opinion of representative men in radiology, personal conversations outside of the meeting room were of the greatest value. It may be said here that they show a very broad knowledge of the subject and a realization of its limitations, which, however, they do not permit to dampen their enthusiasm. The writer takes this opportunity to thank them for the kind reception accorded him at the Congress and in the different clinics he visited.

G. Failla.

New York City.

THE LEONARD PRIZE FOR RESEARCH

The American Roentgen Ray Society will award $1000.00 to the author of the best piece of original research in the field of the roentgen ray, radium, or radioactivity. The competition is open to anyone living in the United States, or its possessions, in Canada, Mexico, Central or South America, Cuba or other islands of the Western Hemisphere.

The field of research includes discovery, invention, improvement of method, or investigations to prove or disprove any theory or problem, whether old or new, which has a direct bearing upon the use of roentgen rays, radium, or other radioactive substances.

This competition is not open to any research involving a patent or copyright,

and the submission of any research work for this prize carries with it the understanding that the subject matter will remain open to free use for the general good.

The committee reserves the right to withhold the award if in its judgment no piece of research offered possesses sufficient merit. It also reserves the right to divide the award if two or more papers are judged to be of equal merit. A certificate of honorable mention will be given to the author of meritorious research which has been submitted, but which has not received the prize.

Papers presented to the committee for consideration must be typewritten in the English language and submitted not later than May 1, 1925. They must be written on plain paper and enclosed in a plain envelope so that the identity of the contestant will not be known to the committee until after the award is made. A plain sealed envelope marked with the title of the paper and enclosing the contestant's name must accompany the manuscript; and after the award has been made, this envelope will be opened and the identity of the winner revealed.

Papers, records, or material are received in this competition only with the understanding and agreement that any work receiving award or honorable mention may be published in THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY at the discretion of the research committee. All expenses of publication will be borne by the Journal. Papers not published will be returned to the authors.

The piece of original research receiving award must be presented before the American Roentgen Ray Society at its annual meeting in September, 1925.

The prize is offered in an altruistic spirit for the promotion of useful research, with the approval of the National Research Council. It commemorates the name of a martyred member of the American Roentgen Ray Society, Dr. Charles Lester Leonard, who paid the supreme penalty for his pioneer research in the field of the roentgen ray.

COMMITTEE

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MEETINGS ON RADIOLOGY AT A.M.A. CONVENTION

Officers

Chairman: W. F. MANGES, Philadelphia.
Vice-Chairman: ALBERT SOILAND, Los Angeles.
Secretary: M. J. HUBENY, Chicago.

THURSDAY, JUNE 12, 9 A. M.

1. Chairman's Address. W. F. MANGES, Philadelphia.
2. Roentgen-Ray Studies in Hydrocephalus (Lantern Demonstration). P. M. HICKEY.
   Discussion to be opened by G. L. DAVENPORT.
3. A Radiographic Study of the Infant's Chest as Seen at Birth. W. WALTER WASSON.
   Discussion to be opened by CHARLES C. GRANDY.
4. Radiographic Localization of Lung Abscess with the Hirtz Compass: Preliminary Report (Lantern Demonstration). L. R. SANTE and E. P. LEHMAN.
   Discussion to be opened by EDWIN S. BLAINE, and EVARTS A. GRAHAM.
5. The Importance of Careful Roentgen-Ray Investigations of Apical Chest Tumors (Lantern Demonstrations). HENRY K. PANCOAST.
   Discussion to be opened by WILLIAM A. EVANS.
6. Some Observations on the Use of the Roentgen Rays in the Diagnosis of the Pericardium (Lantern Demonstration). GEORGE W. HOLMES
   Discussion to be opened by P. D. WHITE.
7. Results of Medical Treatment of Gastric Ulcer as Observed by Serial Roentgenography.
   LOUIS GREGORY COLE.
   Discussion to be opened by BERTRAM W. SIPPY.
8. A Study of Thirty-One Cases of Complete Transposition of the Viscera, with Remarks on Etiology (Lantern Demonstration). L. T. LEWALD.
   Discussion to be opened by JAMES T. CASE.

FRIDAY, JUNE 13, 9 A. M.

9. Studies on the Effect of Roentgen Rays on Glandular Activity; The Effect on Gastric Secretion of Exposure of the Abdominal and Thoracic Areas in Roentgen Rays; A Note on Roentgen Cachexia (Lantern Demonstration).
   A. C. IVY and B. H. ORNDOFF.
   Discussion to be opened by CHARLES L. MARTIN.
10. The Reaction of Different Types of Abdominal Tumors to Radiation. A. U. DESJARDIN.
    Discussion to be opened by GEORGE E. PFAHLER.
11. End-Results Observed in Carcinomas of the Uterine Cervix with Radium and Roentgen-Ray Therapy (Lantern Demonstration). H. SCHMITZ.
    Discussion to be opened by JOHN F. MCCULLOGH.
12. Comments on the Use of Radium for Intra-Oral Cancer. ALBERT SOILAND.
    Discussion to be opened by FRANK E. SIMPSON.
13. The Treatment of Hyperthyroidism by the Roentgen Ray: Results in 125 Cases.
    T. A. GROOVER, A. C. CHRISTIE and E. A. MERRITT.
    Discussion to be opened y ROBERT G. ALLISON.
14. Relations of Roentgen-Ray Signs to Symptoms in Duodenal Ulcer. A. W. CRANE.
    Discussion to be opened by E. C. ERNST.
15. The Pathologic Basis for Irradiation of Tonsils.
    W. W. WATKINS.
    Discussion to be opened by ROBERT A. ARENS.

DEPARTMENT OF TECHNIQUE

Department Editor: DAVID R. BOWEN, M.D., Pennsylvania Hospital, Philadelphia, Pa.

In this department will be published from time to time, as material is available, suggestions for improvement in technique.

A COMPARISON OF THE TELEOROENTGENOGRAM WITH THE ORTHODIAGRAM*

PAUL C. HODGES, M.D.

Department of Roentgenology, Peking Union Medical College

PEKING, CHINA

INTRODUCTION

IN the course of the extensive use of roentgen rays in the study of hearts by Bardeen,[1] Eyster,[3] Meek and other Wisconsin workers, it has become more and more obvious that estimates of cardiac area from teleoroentgenograms frequently fail to check with similar measurements made from orthodiagrams. Since both methods are used clinically, it seemed worth while to undertake the following investigation in the hope of finding the causes and perhaps the remedy for these discrepancies between the two.

Table I is a comparison of teleo areas with ortho areas in 32 cases, some normal, some with cardiac lesions, selected at random from a series of several hundred subjects examined by Dr. Eyster. In column "T" are teleo areas in square centimeters corrected for distortion, in column "O" orthodiagram areas. Under "D" appear percentage variations of teleo areas from ortho areas.

The teleoroentgenograms were made by the standard method[1] with the tube at a distance (in this case 7 ft.) and the subject seated, leaning forward 20°, and holding his breath in moderate inspiration.

The orthodiagrams were made with the subject sitting erect and breathing quietly.

Fifty-four per cent of these cases show the teleo 10 per cent or more larger than the ortho, the greatest variation being 27 per cent, the least 1 per cent, and the average 11 per cent. In 2 cases the teleo is smaller than the ortho, 5 per cent in one, 1 per cent in the other case. Applying Pearson's Product-Moments formula

$$r = \frac{MT \times O - MT \times MO}{\sqrt{MT^2 - M^2T} \times \sqrt{MO^2 - M^2O}}$$

the correlation "r" is found to be .9122 where r = the correlation between teleo area and ortho area; MT = the mean of the teleo areas; MO = the mean of the ortho areas; MT times O = the mean of the summation of the products of the individual T areas by O areas; MT^2 = the mean of the summation of the squares of the T areas; MO^2 = the mean of the summation of the squares of the O areas. M^2T = the square of the mean of the summation of the T areas and M^2O = the square of the mean of the summation of the O areas.

The standard deviation (sigma) for T is 22.01, that for O being 23.04. This is obtained from the formulae

$$\text{Sigma T} = \sqrt{MT^2 - M^2T}$$

$$\text{Sigma O} = \sqrt{MO^2 - M^2O}$$

The findings are in agreement with the idea that having the subject lean forward increases the teleo area on an average of about 10 per cent over the area in the erect position[1] but they show also that even when the 10 per cent correction is applied, many cases show a deviation above 10 per cent, one case being as high as 17 per cent. Cases published by Karshner and Kennicott[4] show individual variations ranging from 0 to 60 per cent. When similar measurements on the same individuals show variations much larger than the normal variations from the normal

* (From the Physiological Laboratory, University of Wisconsin.

tables, interpretation becomes exceedingly difficult.

In the teleo position (Fig. 1), the subject leans forward to throw his heart against the anterior chest wall and holds his breath in a moderate inspiration to assure a sharp diaphragmatic shadow and thus aid in outlining the apex of the heart.[1]

In the ortho position (Fig. 2), he sits erect and breathes quietly. A specially balanced fluoroscope would be required to allow doing the ortho with the subject leaning forward, and the time required for the examination is so long that the breath could not be held except by great effort. It is quite simple, however, to make the teleo with the subject in the ortho position. This we proceeded to do, using the apparatus shown in Figure 3.

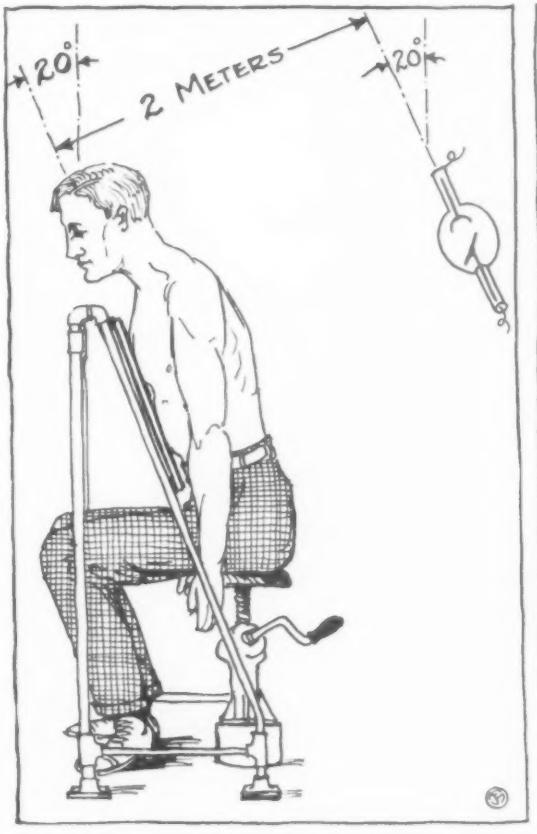

FIG. 1.

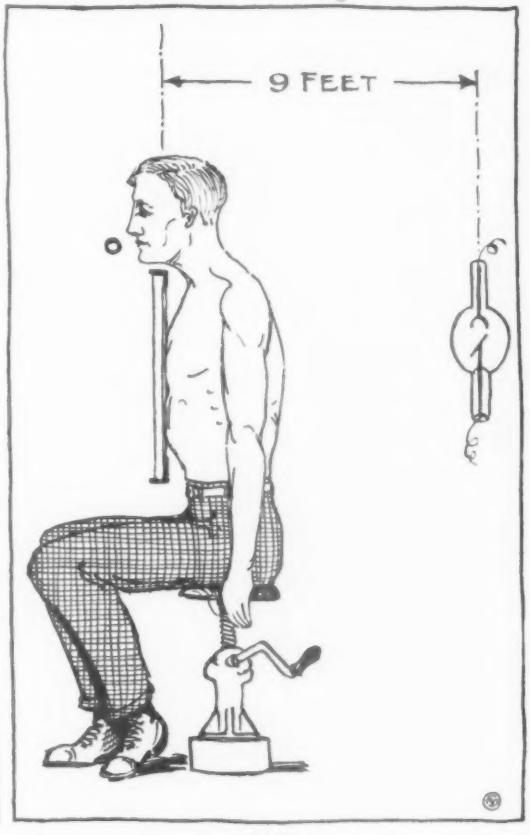

FIG. 2.

The apparatus consists of a specially constructed film changer for 10 × 12 cassettes mounted rigidly in front of a vertical fluoroscope. A 10 × 12 fluoroscopic screen is mounted in a frame exactly the same size as the cassettes so that it can be substituted for one of them. Clips on the front of the screen frame receive window glass cut to size and bound about the edge with adhesive tape.

The fluoroscope is provided with cross wires accurately centered in the line of the central ray from the tube and the counter balance weights have been shifted to the side so that when the tube carriage is moved to the upper limit of its travel there is an unobstructed opening behind the subject. Opposite this opening, but back at a point 9 ft. from the screen, a second tube is mounted in a commercial type of tube stand which has an automatic vertical stereoscopic shift. This tube is set so that when it is at the middle of its shift the central ray falls on the center of the fluoroscopic screen.

The fluoroscopic tube, a 10 ma. radiator type Coolidge tube, is energized from a

small transformer mounted on a wall shelf, the control box being at the left of the observer's chair. The distant tube, a medium focus regular Coolidge type, is supplied from an interrupterless transformer apparatus. Magnetic triggers on the film changer and tube shift are in series with a push button on the interrupterless transformer switch board.

This done, the fluoroscopic tube is raised to the upper limit of its travel, the fluoroscopic screen removed and replaced by a loaded cassette, and a teleoroentgenogram made without changing the position of the subject. Centering the heart fluoroscopically allows the use of 10 × 12 films instead of the customary 14 × 17 size thus considerably decreasing the cost.

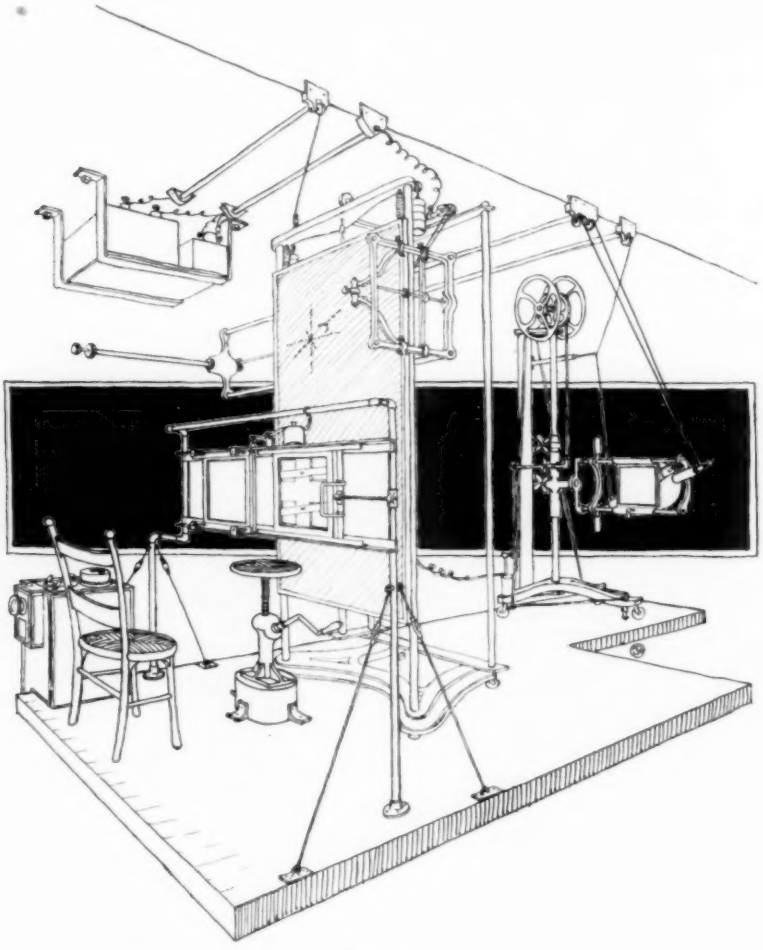

FIG. 3.

Operation. The subject is seated on an adjustable stool which is fastened to the floor just behind the fluoroscopic screen. Under fluoroscopic control this stool is raised or lowered until the center of the heart shadow coincides with the center of the screen. An orthodiagraphic tracing is then made on the tape bound glass and later transferred to paper for measurement.

Correction for Distortion by Divergence of the Rays. Even at a film-target distance of 9 ft., there is, of course, some distortion of the heart shadow, the amount usually being computed by triangular proportion on the assumption that the mean plane of the heart is in the average case 8 cm. from the film.[1] As a matter of fact the surface of the chest never comes up to the plane of

the film—being held away from it by the thickness of the cassette, cassette changing mechanism and the wood or celluloid window against which the subject leans. A more accurate and a simpler method of computing distortion is to erect a rectangular sheet of lead parallel to the celluloid window and 8 cm. back of it, make a teleoroentgenogram, measure with a planimeter the area of the shadow cast by the lead on the film and compare this with the actual area of the lead sheet. Using this method it was found that the distortion for this particular apparatus was 5 per cent.

Experiments. Records were made of 32 males and females, mostly young adults; some normal, some with definite cardiac lesions.

An orthodiascopic tracing was made during quiet breathing, then with the subject holding the same position, two teleoroentgenograms were made, the first during quiet breathing, the second during a held inspiration.

Data. Table II shows teleo areas of subjects in inspiration, sitting erect, compared with ortho areas in the same subjects sitting erect and breathing quietly. Twenty-two per cent of the cases show teleo areas varying from the ortho areas by 10 per cent or more. The largest plus variation is 23, the largest negative 10, the average being plus 4. In 4 cases the two measurements are identical. The correlation factor is .926.

In Table III teleo areas of subjects sitting erect and breathing quietly are compared with ortho areas made under identical conditions. One case shows a teleo 11 per cent larger than its ortho but in all the others the variations are less than 10 per cent and equally distributed be-

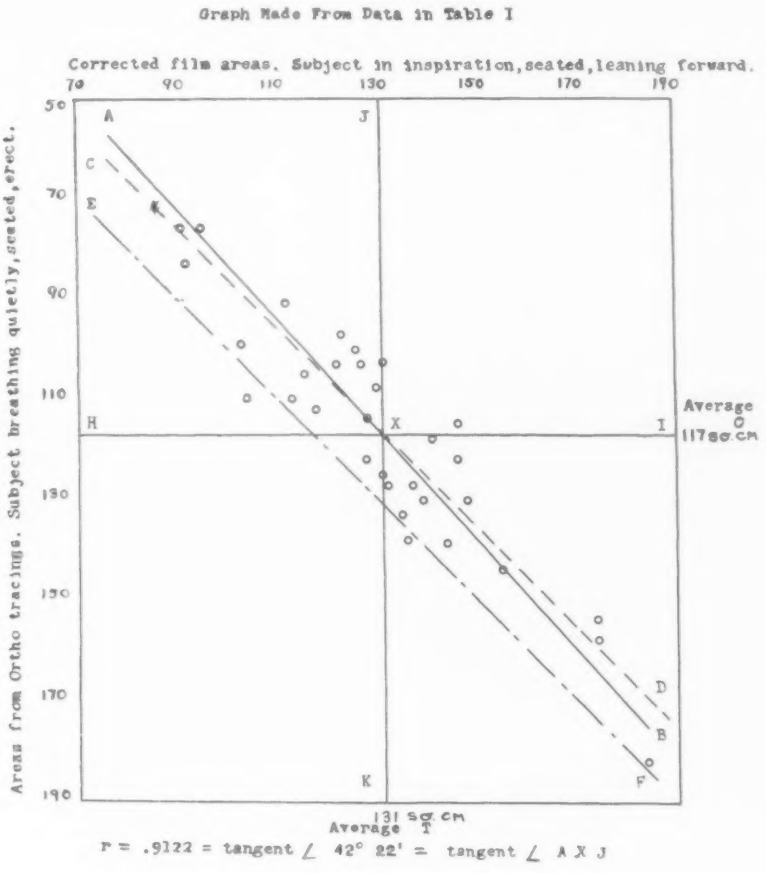

FIG. 4.

tween plus and negative so that the averages are identical. The correlation factor is .951.

Findings from Tables I, II and III are graphically shown in Figures 4, 5 and 6, where areas from teleo films, measured in square centimeters and corrected for distortion are plotted as abscissae with ortho areas in square centimeters, as ordinates.

Discussion. In the graph from Table I practically all of the points are displaced upward from the line EF which is accounted for by the fact that the average teleo is 11 per cent larger than the average ortho. Moreover when this 11 per cent correction is applied, that is when we consider CD as the base line, the points are rather widely scattered above and below it leaving a strong probability of a large individual variation.

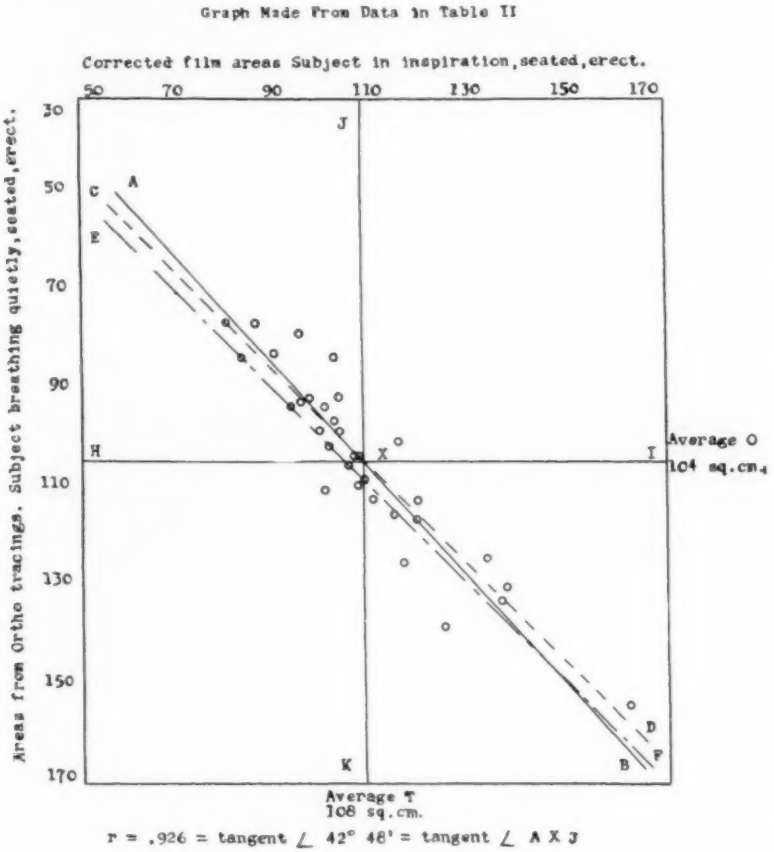

FIG. 5.

The solid line HI is the average of the ortho measurements, JK that of the teleos. The dotted line EF indicates the position that would be taken by the points if every teleo area were exactly equal to its corresponding ortho measurement, CD being the position that would be taken if every teleo bore the same relation to its ortho that the average teleo bears to the average ortho. The solid line AB shows the mean position of the points as they actually lie. It is located by extending the line AX which is the side of an angle AXJ whose tangent is equal to the correlation factor of the values involved.

The graph from Table II shows the line EF much nearer to CD since the average teleo is now more nearly the same size as the average ortho. The points are also packed somewhat more closely about their mean AB.

Table III gives a graph in which EF and CD are identical because the average teleo and average ortho are identical. The

points are quite closely packed about AB and the chances are strongly in favor of an individual variation of well under 10 per cent. There is reason to believe that the variations remaining are really a measure of the personal error in making the readings, and it is logical to suppose that, allowing for distortion, the heart shadows as thrown on the film in the case of the teleoroentgenogram and the screen in the orthodiagram are identical for a given case.

It is usually admitted that an orthodiagram made by a skilled worker contains certain information about the condition of the heart chambers which cannot be obtained from the flat teleoroentgenogram.[4] On the other hand the objectiveness of the latter makes it of definite value in determining the size of the heart as a whole. If we are to use both methods certainly we should be able to compare the findings. Making identical the conditions of the two examinations seems to make this possible, and it may be that the average of the two is the measurement we should use for comparison with the normal tables.

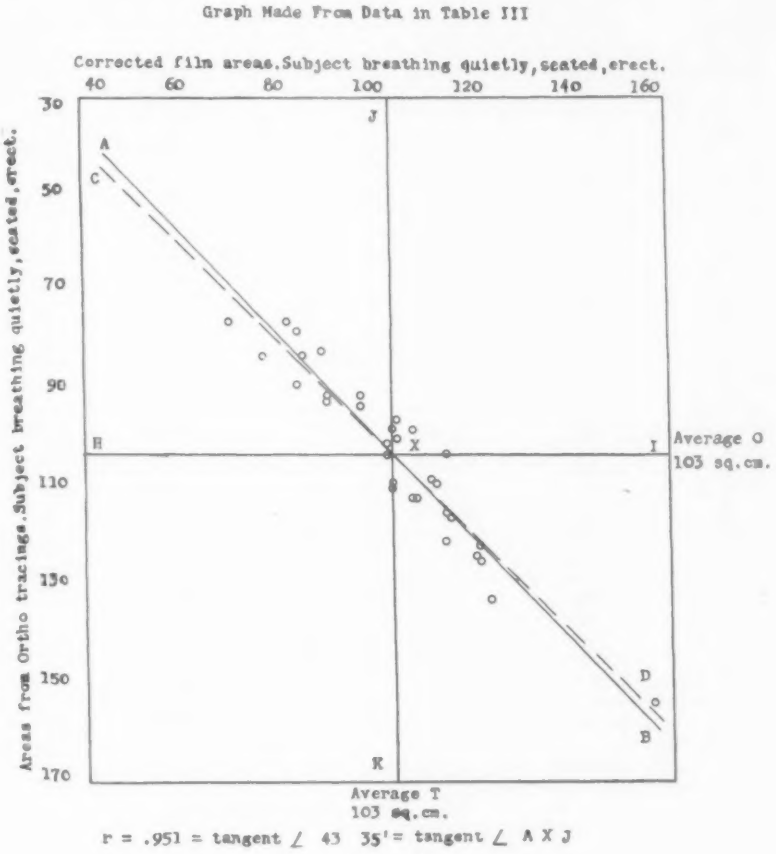

FIG. 6.

SUMMARY

Individual variations between teleoroentgenograms made with the subject in inspiration and leaning forward and orthodiagrams with the subject erect and breathing quietly are larger than normal variations from the normal tables.

The variations are less when the subject sits erect for the teleoroentgenogram.

When the subject sits erect and breathes quietly during both teleoroentgenogram and orthodiagram, individual variations are almost always less than 10 per cent.

TABLE I

	Case	T	T^2	O	O^2	T × O	D
	H_4	174	30276	154	23716	26796	+13
	H_5	104	10816	110	12100	11440	−5
	H6	128	16384	116	13456	14848	+10
	H7	118	13924	112	12544	13216	+5
	H8	135	18225	113	17689	17955	+1
	H9	91	8281	76	5776	6916	+20
	H10	92	8464	83	6889	7636	+11
	H13	130	16900	108	11664	14040	+20
	H312	95	9025	76	5776	7220	+25
	H1	136	18496	138	19044	18768	−1
	H2	148	21904	130	16900	19240	+14
	H3	116	13456	105	11025	12180	+10
	H15	126	15876	100	10000	12600	+26
	H19	127	16129	103	10609	13081	+23
	H20	132	17424	127	16129	16764	+4
	H21	128	16384	122	14884	15616	+5
	E411	141	19881	118	13924	16638	+19
	E343	131	17161	103	10609	13493	+27
	E397	103	10609	99	9801	10197	+4
	E10	184	33856	182	33124	33488	+1
	E11	112	12544	91	8281	10192	+23
	E12	113	12769	110	12100	12430	+3
	E13	123	15129	97	9409	11931	+27
	E16	146	21316	122	14884	17812	+20
	E15	146	21316	115	13225	16790	+27
	E17	155	24025	144	20736	22320	+8
	E18	174	30276	158	24964	27492	+10
	E21	137	18769	127	16129	17399	+8
	E25	144	20736	139	19321	20016	+4
	E22	139	19321	130	16900	18070	+7
	E98	122	14884	103	10609	12566	+18
	E72	131	17161	125	15625	16375	+5
Total.....	.....	4181	561717	3756	457842	505525	
Average.....	.....	130.65	17553.65	117.375	14307.56	15797.65	
Sigma.....	.....	22.01	.....	23.04			
r = .9122 P.E. r = .029							

T = Corrected film area. Subject in inspiration, seated, leaning foward.
O = Cardiac area from ortho tracings. Subject breathing quietly, seated, erect.
D = Percentage deviation film area from ortho area.

TABLE II

	Case	T	T^2	O	O^2	T × O	D
	H4	162	26244	154	23716	24948	+5
	H5	100	10000	110	12100	11000	−9
	H6	119	14161	116	13456	13804	+3
	H7	119	14161	112	12544	13328	+6
	H8	136	18496	133	17689	18088	+2
	H9	80	6400	76	5776	6080	+5
	H10	83	6889	83	6889	6889	0
	H11	106	11236	103	10609	10918	+3
	H12	93	8649	93	8649	8649	0
	H13	108	11664	108	11664	11664	0
	H312	86	7396	76	5776	6536	+13
	H306	95	9025	78	6084	7410	+22
	H307	90	8100	82	6724	7380	+10
	H308	116	13456	115	13225	13340	+1
	H309	97	9409	91	8281	8827	+7
	H310	102	10404	96	9216	9792	+6
	H311	103	10609	91	8281	9373	+13
	H313	95	9025	92	8464	8740	+3
	H314	102	10404	83	6889	8466	+23
	H316	110	12100	112	12544	12320	−2
	H317	101	10201	101	10201	10201	0
	H318	103	10609	98	9604	10094	+5
	H319	99	9801	98	9604	9702	+1
	H1	124	15376	138	19044	17112	−10
	H2	137	18769	130	16900	17810	+5
	H3	105	11025	105	11025	11025	0
	H301	100	10000	93	8649	9300	+5
	H321	133	17689	124	15376	16492	+7
	H15	115	13225	100	10000	11500	+15
	H17	116	13456	125	15625	14500	−7
	H18	107	11449	109	11881	11663	−2
	H19	107	11449	103	10609	11021	+4
Total.....	.....	3449	380877	3328	357094	367972	
Average.....	.....	107.78	11902.4	104	11159.18	11499.125	
Sigma.....	.....	17.10	.....	18.52			
r = .926 P.E. r = .024							

T = Corrected film area. Subject in inspiration, seated, erect.
O = Cardiac area from ortho tracings. Subject breathing quietly, seated, erect.
D = Percentage deviation film area from ortho area.

TABLE III

	Case	T	T^2	O	O^2	T × O	D
	H4	156	24336	154	23716	24024	+1
	H5	103	10609	110	12100	11330	−6
	H6	115	13225	116	13456	13340	−1
	H7	108	11664	112	12544	12096	−4
	H8	123	15129	133	17689	16359	−8
	H9	70	4900	76	5776	5320	−8
	H10	85	7225	83	6889	7055	+2
	H11	102	10404	103	10609	10506	−1
	H12	97	9409	93	8649	9021	+4
	H13	111	12321	108	11664	11988	+3
	H312	82	6724	76	5776	6232	+8
	H306	84	7056	78	6084	6552	+8
	H307	89	7921	82	6724	7298	+9
	H308	114	12996	115	13225	13110	−1
	H309	90	8100	91	8281	8190	−1
	H310	104	10816	96	9216	9984	+8
	H311	97	9409	91	8281	8827	+7
	H313	90	8100	92	8464	8280	−2
	H314	77	5929	83	6889	6391	−7
	H316	107	11449	112	12544	11984	−4
	H317	102	10404	101	10201	10302	+1
	H318	107	11449	98	9604	10486	+9
	H319	103	10609	98	9604	10094	+5
	H320	114	12996	121	14641	13794	−6
	H321	120	14400	124	15376	14880	−3
	H15	104	10816	100	10000	10400	+4
	H17	121	14641	125	15625	15125	−3
	H18	112	12544	109	11881	12208	+3
	H19	114	12996	103	10609	11742	+11
	H21	121	14641	122	14884	14762	−1
	H322	103	10609	110	12100	11330	−6
	H323	84	7056	89	7921	7476	−6
Total.....	.....	3309	350883	3304	351022	350486	
Average.....	.....	103.40	10965.09	103.25	10969.43	10952.68	
Sigma.....	.....	16.54	.....	17.58			
r = .951 P.E. r = .016							

T = Corrected film area. Subject breathing quietly seated, erect.
O = Cardiac area from ortho tracings. Subject breathing quietly, seated, erect.
D = Percentage deviation film area from ortho area.

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BOOK REVIEWS

Books Received Are Acknowledged under Heading: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

LEHRBUCH DER PHYSIKALISCHEN, BIOLOGISCHEN UND KLINISCHEN GRUNALAGEN ZUR STRAHLEN-TIEFEN- THERAPIE UND IHRER ANWENDUNG IN DER GYNÖKOLIGIE. By Prof. Dr. Ernst von Seuffert, with an introduction by Prof. Dr. A. Döderlein, Berlin, 1923, S. Karger. Pages xxii, 559, with 77 cuts in the text and 21 tables.

The title of this book, "A Textbook of the Physical, Biological and Clinical Foundations for Deep Therapy and its Employment in Gynecology" expresses very well its purpose. The author in his foreword, however, qualifies his title by saying very truly that he feels that it is impossible to write a textbook on deep therapy, and he wishes it to be distinctly understood that he attempts only to give the foundation principles thereof. He feels that actual deep therapy technique can be learned only in the therapy room.

An effort has been made to give us not only the results of work in the Döderlein Clinic at Munich but also the work of the other most important clinics in Germany which have been interested in deep therapy, such as Erlangen and Freiburg, together with some of the work of Bumm and Warnekros. The physician who himself is not a roentgenologist, but who wishes to understand the possibility and methods of deep therapy that he may advise his patient in an intelligent manner, has been kept in mind also. The author further expresses his hope that he has been able to simplify the physical and technical side of the work to such an extent that it may be readily understood by those of us who are not specially educated along physical and mathematical lines. Whether he has succeeded, may best be judged by those who read the volume in detail.

Approximately half of the book is taken up with the physical and technical part, and in this part there is first a section devoted to a thorough consideration of rays and ray-measurements. The detail with which everything is treated can be seen from the fact we have here a beginning with the atomic theory. Both radium and roentgen rays are studied. The section on measurement embraces qualitative and quantitative and is brought down to include iontoquantimetric measurements. Gynecological dosage, or, as the author terms it, actual radiation technique, is thoroughly discussed, with the development of the various methods in vogue in the clinics of Erlangen, Munich and elsewhere. Combined radium and roentgen-ray treatment is considered here.

Then follows a section devoted to the method of generation of artificial gamma rays beginning with an extensive discussion of electricity and gradually leading up to a consideration of the modern forms of roentgen-ray apparatus, naturally of the German type. There is similarly an exhaustive discussion of tubes gas and gas free. This concludes the technical part of the book.

The biological-clinical part begins with the study of the biological effect of the rays and the question of the determination of the proper biological dosage. Another section takes up the question of hypersusceptibility to the rays, both local and general. The possibility of increasing the bodily resistance to heavy dosage by means of transfusion and radiation of the pituitary is considered also.

The latter part of the clinical section is devoted to a thorough survey of roentgenotherapy in gynecology, beginning first with nonmalignant conditions, with indications for and against treatment. The radiation treatment of younger women and the possibilities of the treatment without any danger to the sexual life of the patient are tohroughly discussed.

There is a complete survey of the use of the deep roentgen-ray therapy in malignant conditions. The various arguments for and against therapy as opposed to surgery are considered in detail. The experience of the various German clinics is shown, with their statistics. The experience of the author is shown very decidedly to favor radiation rather than operation.

There is finally a chapter devoted to pre- and post-radiation treatment.

One is impressed by the thorough mastery of the subject which the author shows and which well bears out the statement of Döderlein in the introduction that von Seuffert is suited as are very few to attempt to give us a book of practical value. The fact that he is not primarily a laboratory man but a clinician as well makes his viewpoint all the more valuable. His book represents very fairly the status of radiation therapy in Germany along gynecological lines, at the time of its publication.

Throughout the book there are many interesting personal observations, among which there are two of striking, interest. He mentions that it has been his experience that following radiation there has been a marked improvement in patients afflicted with chronic constipation, and similarly considerable benefit in cases of prolapse. This latter effect has evidently been due to the fibrosis produced. No explanation is offered as the reason for the improvement in chronic constipation.

E. C. Samuel and E. R. Bowie.

Die Röntgenbehandlung innerer Krankheiten. (Roentgen treatment of internal diseases.) Edited by Fritz Salzmann. Price; paper, $2.00, cloth, $2.50. Plates 55. J. F. Lehmann, München, 1923.

The necessity for a critical review is quite apparent when one considers the enormous progress made during the past six years in the relatively young science of radiation therapy. Such a review, and much more, is offered in the present volume. The seventeen authors who have collaborated in this work present not only a review, but also well-balanced presentations of their various specialties. In every chapter, the development of radiation therapy is traced and its bearing upon the clinical side is discussed, the entire organism being taken into consideration. An interesting aspect of the book is discussion of the problems still under dispute. Measurement and dosage are considered in two chapters, and the practical applications in every branch are set forth. Any tendency to one-sided treatment seems to be corrected by the fact that in some instances the opinions differ. The title of the book is not sufficiently comprehensive, because, in addition to the treatment of pulmonary tuberculosis by Bacmeister, there are chapters for each of the following: Radiation therapy of glandular and peritoneal tuberculosis, by Stepp; roentgen therapy of the structural tissues, the nontuberculous bone and joint diseases, and the treatment of malignant tumors. Moreover, two extensive chapters are presented which deal with the physical and biological foundations of radiation therapy. It is therefore quite evident that this work covers the wide field of general and special radiation therapy. The surgeon will find interest in the chapters on Basedow's disease, hypophyseal tumors and their treatment by roentgen radiation of the nervous system; the gynecologist, in the chapter on roentgen therapy in disturbances of the internal secretions of the ovary. For the first time, the internist is offered a compilation of Groedel's experiences upon the effects of radiation in diseases of the cardiovascular system. Separate chapters are also given to the hitherto poorly understood conditions of bronchial asthma and diseases of the thymus and the pancreas. A short discussion is given of roentgen injuries and the extent of the liability of the roentgenologist. The masters in the profession of radiation therapy will find this a work for ready reference and the beginner will have the advantage of the combined experiences of outstanding experts.

G. F. Haenisch.

INTERNATIONAL ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROST, G. A. Radiation therapy of skin cancer. *Strahlentherapie*, 1923, xv, 782.

The author distinguishes between primary and secondary cutaneous cancer. He follows Darier in his differentiation of the primary group in spindle-cell, basal-cell carcinoma, and a metatypical growth uniting the characteristics of the two previous groups. The first comprises about 50 per cent of all cases of cutaneous cancer. The second, 30 to 40 per cent, and the third, 10 to 15 per cent. Spindle-cell carcinoma is malignant and generally attacks the face, ears, mouth, and in some instances the rest of the body. It most often starts as a wart-like formation on the skin, and as a "verucose leucoplacia" on the mucous membrane. It develops comparatively rapidly, the lymph glands are soon involved, and death often occurs within a few years from cachexia and hemorrhage. Its response to radiation varies. In the average case it is not very prompt, and most failures of this therapy are registered in this type of cutaneous cancer. Basal cell cancer is most often located on the upper two-thirds of the face, especially in older people. It may appear on the extremities, lips, tongue, and genital organs. Its development requires from twelve to thirty years. It is obstinate, and prone to recurrence when operated upon. Its malignancy is entirely local, and the growth rarely spreads to the glands and metastases are not formed. Darier distinguishes five types, one of which is the so-called ulcus rodens. Basal cell carcinoma is very sensitive to radiation.

Basal cell carcinoma may be treated with roentgen rays, while on the whole operation is to be preferred on parts of the body which respond less readily to radiation. These regions are the penis, hand, ears, the lower part of the lower extremity, and feet. Inoperable tumors may be rendered operable by roentgen treatment. Where cosmetic effect is of importance, radiation will be employed. This is desired, for instance, in the naso-labial region, and the corners of the eye-lids. The extent of the lesion, either on the surface or in the deeper layers of the skin, will constitute a contraindication for operation.

The author considers radium and roentgen rays as of equal value. The same results may be seen from both, and their choice will greatly depend on circumstances. However, it seems that in those carcinomata which no longer respond to roentgen rays, and in some that do not respond to it from the onset, radium might be of use. The same may be the case in the reverse.

Most practitioners go beyond the cutaneous erythema dose, sometimes to the third of its extent, and 3 to 4 mm. Al. is used as filter. The author's normal dose is 90 to 110 per cent of the cutaneous erythema dose.

Rost is of the opinion that it is impossible to give a review of the results obtained by various authors because the methods employed are not the same.

SIMMONS, C. C., and DALAND, E. M. Cancer: Delay in the surgical treatment. *Boston M. & S. Jour.*, Jan. 3, 1924, cxc, 15–18.

The following questions were asked, and the answers recorded in the 519 cases of cancer which entered the Mass. Gen. Hosp. in 1917–1918.

1. Character and date of first symptom.
2. Date of first consultation with a physician.
3. Date on which operation was advised and by whom.
4. Date of admission to the hospital.

(*a*) The average duration of the disease before admission into the hospital, 12.49 months.

(*b*) The average delay on part of patient from onset to consultation with a physician, 5.4 months.

(*c*) The average delay from first consultation to operation was advised, 3 months.

The average delay in breast cancer was 12.4 months. In 1921–1922, a similar study was made of the 539 cases. In cancer of the rectum, the operability of those cases reaching the surgeon, is about 50 per cent; the operability of the disease is, therefore, not over 25 per cent. If the percentage of cases of cures of cancer of the rectum, operated on, is 25 per cent, the percentage of cures of all cases of the disease, is 6 per cent. There is but slight difference between the findings of 1917–18, and those of 1921–22.

The average duration of the disease, before admission, was 11.6 months as compared with 12.49 of previous series. The average delay from onset to first consultation, was 4.6 months as against 5.4 months for the previous series.

Delay from first consultation to operation advised, 2.9 months as against 3 months.

A tabular statement is given of the entire facts.

SIMPSON, FRANK EDWARD. Recent advances in radium therapy. *Chicago M. Rec.*, Oct., 1923, xlv, 795–801.

In treatment of malignancy by radium, both underdosage and overdosage must be avoided. Underdosage may fail to influence, and overdose may hasten the patient's end.

The advantages of treatment by radium emanation are that the most lethal rays are brought into close contact with cancer cells for about five days, that the effect is selective—the cancer cells are more injured than the normal, and that the dosage is quite exact, 0.5 millicuries per c.c. of tissue, is ordinarily enough.

The ampoules must not be implanted too near large vessels, hollow viscera or bone.

Draining lymphatic glands should receive heavy radiation with 500 to 1000 or more millicuries placed 3 or more cm. from the surface.

Of 17 carcinomata of the tongue, 12 appear to be clinically well for periods from three months to two and one-half years. One case (inoperable) is still uncertain; 4 cases (inoperable), have died since treatment.

PERROLA, ALBERT. The treatment of inoperable cancers of the cervix before and after the employment of radium. (Le traitement des cancers du col inoperables avant et depuis l'emploi du radium.) *Rev. Francaise de Gyn. et Obst.*, May, 1923, xviii, 321–329.

The author collected 50 cases of inoperable cancers of the neck of the uterus which he classifies into:

(*a*) Inoperable cancer of the neck: cratered, light infiltration of the cul-de-sac and surroundings; 30 cases.

(*b*) Inoperable cancer of the neck: cratered, block neoplasm; 20 cases.

The age varied from thirty-four to eighty years with an average of fifty-four years.

As for the treatment instituted the greater part of our patients (42) have had curettage of the neoplastic mass followed nearly always by cautery with a red hot iron (30 cases), by the thermocautery (11 cases). More rarely, the cauterization was done by nitric acid (three times), the tincture of iodine (2 cases), nitrate of silver (one case) and formol (one case).

There was no recovery and but little amelioration in these 50 cases. He then gives 46 cases treated with radium divided as before:

(*a*) 25 cases inoperable, cratered, with light infiltration of the cul-de-sac and surroundings.

(*b*) 21 cases inoperable, cratered, block neoplasm.

We have exact information of the final result of each case of the patients who figure in the following table:

(*a*) 25 cases inoperable:
  (1) 22 cases:
    6 months shortest time survived.
    67 months longest time survived.
    28½ months average time survived.
  (2) 3 cases yet alive with duration of clinical cure:
    66½ months, 67½ months, 74 months.

(*b*) 21 cases inoperable, block neoplasm:
  (1) 19 cases.
    shortest survival 3½ months
    longest survival 49½ months
    average survival 14 months.
  (2) Two patients,—condition unknown.

Though based on so small a number of cases, the figures of our statistics have significance. Three patients with inoperable cancer of the neck yet alive five years after the first application of radium and one six years and two months and among those dead the average survived twenty-eight and one-half months in the first group and fourteen months in the second.

GARRAHAN, JUAN P. Pleurisy of the apex in tuberculous children. (Pleuritis de vertice en los niños bacilosos.) *Semana méd.*, Aug., 1923, xxx, 281.

This article refers to seven children from six months to six years of age, presenting positive tuberculous reaction with clinical-radiological signs.

When the apex is invaded the roentgen shadow is uniform, or almost uniform, directly comparable to the shadow of the heart, or somewhat less in density, occupying the apex with more or less clear inferior limit. In some cases, the shadow fills almost the entire side, but the base and costo-diaphragmatic space were always free. Nearly always the roentgenographic image was more extended than was verified by percussion.

The roentgenographic examination in all cases which gave positive tuberculin reaction proved the existence of a tracheo-bronchial adenopathy.

There were diverse functional symptoms varying with the evolution of each case, but in general it may be said that all of the children who presented vertex symptoms were thin and pallid, more or less without appetite, febrile, coughing in some cases. Nevertheless, the relative good general condition was in contrast with the intrathoracic condition.

In children with tracheo-bronchial adenopathy, accompanied or not by other bacillary invasion, and who give positive tuberculin reaction, can be observed a process characterized by more or less dulness of one of the apices; above all, in front, a blowing or diminution of the intensity of the respiratory murmur and a uniform roentgen shadow.

If the process is well tolerated, it may be accompanied with fever, cough (rarely by expectoration; absence of B. of Koch), more or less modified general condition and a tendency toward cure from a month to two years.

The clinical picture studied by us corresponds approximately to the "infiltracion epituberculósa" of Eliasberg and Neuland and to the "infiltracion paratuberculósa" of Engel.

The pathological anatomy is not known. Judging from our studies we suspect that the process in question is a pleuritic exudation which is absorbed slowly and which we propose to call "pleurisy of the vertex in tuberculous children."

BUGBEE, HENRY G. Report of cases of malignant growths of the bladder treated by resection and radium. *Jour. Urol.*, August, 1923, x, 159.

He reports 19 cases. In 2 cases the carcinoma was destroyed by actual cautery and the base treated by radium. The remainder by resection and radium. For these he gives a table.

Circumscribed carcinoma should be removed by resection, if possible. Recurrences after operation are less resistant than the primary growth, sometimes yielding to fulguration.

Malignant papillomata should be removed by resection, the line of resection being fortified by the insertion of radium needles. The cases being too recent, he draws no conclusions as to final results.

SKINNER, E. H. The roentgen analysis of the right diaphragm. *Jour. Radiol.*, Aug., 1923, iv, 270.

This article is rather one on roentgen-ray diagnosis of the motions and positions of the entire diaphragm than of the right leaf only.

The left diaphragm makes a measurably deeper excursion than the right. The excursion of the right leaf is about 1.7 cm. and the left 1.5 cm. with quiet breathing. The excursion between full expiration and inspiration is 6 to 8 cm. upon the right and 7.1 cm. upon the left side. These are Williams' figures.

There can be two or more waves observable in the right diaphragm without pathological significance due to uneven contraction of muscle bundles of this fan-shaped muscle. These waves should be disregarded in the absence of clinical symptoms in the right phrenic area.

Gerstenberger shows the necessity of studying the appearance of the elephant-ear-shadow of the thymus in expiration and its disappearance into the heart shadow upon inspiration.

Anatomical studies of the diaphragm bring out the points that the diaphragm is not a single muscle upon either side but that there is the crural portion acting mesially and the parietal portion acting parietally or laterally.

KRETSCHMER, HERMAN L. Pyelography. *Surg. Clin. N. Amer.*, Aug., 1923, iii, 985.

Pyelography is employed both in urology and in general abdominal diagnosis.

The author cautions against the use of a hand syringe and prefers a low hydrostatic pressure and cautions against too rapid overdistending of the ureter and insists upon very slow introduction of the fluid, just to the point of discomfort in the region of the kidney.

In some kidneys removed after pyelography deposits of collargol and colloidal silver have been found.

Pain may be severe and last twenty-four hours. Reflex nausea and vomiting may occur, but they are rare. The author feels that these complications are often the result of too rapid injection of the solution into the kidney pelvis.

Chills and fever may result from a pre-existing infection lighting up. Severe jaundice has followed twice in pyelography in hydronephrosis in the author's experience.

Fatal cases have followed in bilateral pyelography. Some men will not therefore perform a bilateral. A very small ureteral catheter in a measure prevents this overdistension.

The author regards as a normal pelvis one which can hold from 5 to 9 c.c. Others do not regard 15 c.c. as abnormal.

The reason for not making pyelograms in cases of hydronephroses is that these large sacs retain the injection material which results in much pain and perhaps danger. Sodium bromide is reported as causing least disturbance.

Early diagnosis of renal tumors can be made from history and pyelograms. Pyelograms are at times useful in completing the diagnosis of tuberculosis of the kidney. Pyelograms are also of assistance in making diagnosis from gallstones, and from tumor masses in the abdomen.

ROGER, H., AYMES, G., and PIERI, T. Typhoid spondylitis. *Gaz. d. Hôp.*, Sept., 1923, xcvi, 1137–1140.

Osteitis of the long bones often follows typhoid fever but it is rare to find this condition in the spine.

A case of typhoid of medium intensity was followed three months after recovery by a sudden attack of intense lumbar pain, accompanied by clonus but no Babinski sign.

The roentgenogram showed lateral osteophytes on the inferior border of the second lumbar and upper border of the third. The appearance differed from the usual one of osteoarthritis in that there was a thinning of the intervertebral space between the second and third vertebrae while the joint-slits above and below were of normal width. The lower border of the body of the second and upper border of the third vertebrae did not present sharp contours.

The appearance somewhat resembles secondary neoplasm but in such cases the primary growth can usually be located.

ALAMARTINE and CHARLEUX. Degenerated papilloma of the bladder, treated by curiethérapy. *Journ. d' Urol.*, Oct. 1923, xvi, 291–294.

This case, female, 53 years old, entered the service of Prof. Rochet, Sept. 8, 1921, and died June 3, 1923. No special antecedent history; had been operated on for acute appendicitis. The day following operation, the urine was cloudy and bloody. It was then learned that for ten years previously, there had been hematuria, at first spontaneous and intermittent and that for six months it had been continuous. At the same time, there were signs of an intense cystitis. At once a degenerated papilloma was thought of, and a fixed catheter tried, but it gave no relief. On Aug. 16, cystotomy was performed. This disclosed a large vesical tumor, implanted by a broad base in the left side of the bas-fond of the bladder.

Radium, as an application, was preferred to removal, on account of the bad general condition, and the sessile tumor. Radium was applied a second time, four days later. Two tubes of 50 mgm. each, were deeply placed in the tumor.

The radium was kept in place 48 hours, the result being satisfactory. The bleeding lessened rapidly, as did the cystitis. The cystotomy wound closed in 3 months.

Oct. 25, 1921, it was found that the lesion was smaller although base of the bladder was found by rectal touch to be very hard. On Jan. 21, 1922, the action of the radium was clearly manifest, cystoscopy showing only an irregular floor with a small elevation, 1 cm. high. On Mar. 2, 1922, around the left uteral orifice, there was a lightly granulated and cicatricial zone.

The local and functional cure was maintained for a year and a half. The general condition remained good, neither hematuria nor cystitis reappeared. The bladder capacity remained about 150 grammes.

However, two months after the intervention, in Nov., 1921, the patient suffered with the right kidney, which became very large. A hydronephrosis and secondary renal tumor were considered. Nephrotomy was done, which disclosed only a polycystic kidney. Histological examination showed no neoplastic lesion of the renal parenchyma. On Dec. 5, 1922, the patient reentered the clinic on account of a fistula at the line of the former nephrectomy, and died Jan. 3, 1923 of caseous bronchopneumonia.

ANGLE, E. J. and OWEN, L. J. Treatment of cancer of the lower lip with special reference to radium and electro-coagulation. *The Urolog. Cutan. Rev.*, 1923, xxii, 688–692.

In that group of prickle-cell carcinomas of the lower lip when no metastasis to the submental or submaxillary lymphatics has occurred, there is the same certainty of cure by means of radium, as in the basal-cell growth of the upper part of the face.

In a second group, uncertainty enters into the prognosis, when metastasis to the adjacent glands has taken place. It is not always possible to know if metastasis has taken place. A third group of cases is that in which the deeper lymphatics and perhaps the thorax become involved, in which only palliative results can be hoped for; deep cervical metastasis does not prove the presence of thoracic cancer and some of these cases, if the lymphatic chains are treated actively, will get well.

Douglas Quick is quoted as saying, "It would seem, therefore, that the adoption of a radical block dissection, as a blanket rule, is a frantic rather than scientific effort." Boggs says: "Cancer cells located in sublingual, submaxillary, submental, parotid, and cervical glands can be successfully destroyed by implanted radium, in more advanced cases than can be removed by surgery, without producing any deformity." In neck dissection there is widespread opening of lymphatic channels which may increase the malignant metastasis.

Destruction of the primary lesion on the lip, by means of electro-thermic coagulation, seals the lymphatics, without manipulation of the tissues, and is a sound procedure. Beyond the area of actual coagulation there is a zone of heat which while not destructive to the connective tissue cells, is destructive to the cancer cells.

Corbus is quoted as saying, "that diathermy can be used to destroy cancer in areas not

accessible by any other means; that we must use a current low in voltage and high in amperes, only enough voltage being used to drive the current through the tissues."

The great variation in physiologic reactions to raying tissue with radium, has defeated all attempts to formulate an accurate "cancer dose." A cell is less resistant during mitosis, and repeated attacks strike at a greater number of cells in this less resistant state, without giving the tumor time for growth, incident to what would be a stimulation exposure, if long periods elapsed between treatments.

Why basal-cell growths should be the rule above the level of the mouth, on the face and prickle-cell cancers comprise nearly all malignancies of the lower lip, is not clear.

A resumé of results is given and 5 cases reported in detail.

BOOTHBY, WALTER M. The total and basal metabolism in exophthalmic goiter. *Minn. Medicine*, Feb., 1924, vii, 91–92.

The basal metabolic rate is valuable in the differential diagnosis of diseases of the thyroid, and in measuring the intensity of the hyperthyroidism. As the total metabolism in twenty-four hours is increased to even a greater extent than the basal metabolism, the former can be used as a diagnostic aid, and the variation in weight as an index of the course of the disease and the patient's condition. A gain in weight indicates that the patient is doing well, while a continued loss of weight suggests that operation will not be well stood.

About two years ago, H. S. Plummer demonstrated that the gastrointestinal crises of exophthalmic goiter can be stopped by administration of Lugol's solution from 30 to 60 drops for three or four days and then 10 drops daily. Its effect is quite as striking and dramatic as that of insulin in diabetes. Kocher's warning against the indiscriminate use of iodine in goiter should be heeded, because it is likely to change an adenomatous goiter without hyperthyroidism to adenomatous goiter with hyperthyroidism. Therefore, before Lugol's is used, a correct differential diagnosis must be made.

BORAK, J. Uric acid elimination of normal individuals upon exposure to roentgen rays. *Fortschr. a.d. Geb. d. Roentgenstrahlen*, 1923, xxxi, 298.

Experiments showed that endogenous uric acid elimination, which is independent of the food taken, depends on the dose and certain individual variations when normal individuals are radiated, also on the part of the body to which the rays are applied, or the organs contained in these parts.

When medium doses were applied to the thorax, abdomen (not including the liver and spleen) and the lower extremities, no influence on the uric acid elimination was noticed. Twenty-four hours after radiating the liver, and the spleen, uric acid was increased, and associated with urate sediment, in the first phase. Then followed decrease below the normal average, during the second phase, and then a renewed increase, of the third phase which lasted several days.

The author is of opinion that radiation causes a washing out of purin deposits from the radiated organs, just as do atophan and large quantities of fluid.

CAUDIÉRE, MARCEL, and HENRY, J. R. Histological classification of tumors of the testicle. *Gaz. des Hop., Par.*, Nov. 24, 1923, 1505. (Cont. Dec. 1, 1923, p. 1537.)

Tumors of the testicle form a particularly complex group in which the study and histological classification remained long obscure by reason of the complexity of the facts and the difficulty of their interpretation.

The fundamental paper of Pilliet and Costes gave, for the first time, the basis for the classification of tumors of the testicle in accordance with their embryonic origin. A classification of tumors of the testicle, which is not based on the embryonic origin of the different types, cannot be satisfactory. The genital glands by their morphogenesis and histogensis, contain histological elements of very different origin and different potentiality in the production of tumors. It is well, then, to fix in mind the essential embryological points of the genital glands and the origin of their different elements.

The embryology of the testicle is then given.

The histological classification of tumors of the testicle is simple when the embryological origin is taken as a basis for each type. Each distinct type of normal element corresponds to a type of tumor.

Moreover, we must add tumors of mixed origin, embryomas which are frequently found in the genital glands. These tumors may be classified in the following manner: Embryonal (Tumeurs germinatives); interstitial endocrine tumors (Tumeurs interstitielles endocrines); excreto-renital tumors (Tumeurs excreto- genitales); connective tissue tumors (Tumeurs conjunctives); tunica vaginalis tumors (Tumeurs de la vaginale); mixed tumors; embryomas and their derivatives.

1. Embryonal tumors. Seminiferous adenoma. These are rare tumors first described by Pick in 1905, then studied by Chevassee, Ledene, and Pierre Nudal. On section, these

tumors present the aspect of semi-transparent nodules, white or yellow, of a size varying from 1 mm. to 1 cm., and included in the parenchyma of the testicle. Histologically, they are composed of a group of tubes, wrapped on themselves, a group separated from parenchyma of the testicle, surrounded by a connective tissue capsule. These tubes are smaller than normal seminiferous tubules, and are formed by a thin, connective tissue wall lined with cellular elements poorly limited and more or less fixed into a syncytium, recalling strongly the fetal seminiferous tubules.

2. Seminiferous epithelioma, seminoma. The term "seminoma," designates a very characteristic type whose peculiar histological character suggests that it is derived from the male germinal epithelium. This is found commonly in the testicle, exceptionally in the ovary, and Americans say that, practically, seminoma and embryoma are the two types of tumors of the testicle which are much the most frequent.

Interstitial endocrine tumors. Hyperplasias. These hyperplastic tumors of the interstitial cells have seldom been found except in ectopic testicles. They have the aspect of small lobules isolated in the parenchyma of the testicle more or less voluminous. From a histological standpoint, as these elements are only abnormal in number, it is a question whether they are properly called tumors.

Adenomas and interstitial epitheliomas. These tumors are developed in the ectopic or in the normally placed testicle. They may be bilateral. Their volume may be the size of a hen's egg, and their weight more than 200 grams.

3. Tumors, excreto-genital. The Wolffian tubules appear not to give rise to tumors. Those attributed to them, appear to have another origin, and to belong to the embryomas.

4. Connective tissue, and tunica vaginalis tumors. Without doubt, the common connective tissue of the testicle can be the origin of fibromas and sarcomas, but these tumors appear to be extremely rare. A number of tumors for a long time considered sarcomas, are in reality either embryomas or seminomas.

5. Embryonic tumors, mixed tumors. Teratomas and embryomas, so-called mixed tumors, are frequently observed in the testicle, characterized histologically by elements derived from the three blastodermic leaves (tridermic tumors of Münch). They are divided into teratomas and embryomas. The teratomas are tumors enclosing organized remnants more or less recognizable.

Between teratoma and embryoma, there then is only the difference of degree in the complexity of the mixture of tissues of organic remains. They may degenerate into cancers of rapid growth with invasion of distant parts.

Benign neoplasms. The greater part of the mixed tumors belong to this group.

With this article, there is a bibliography of 55 articles.

Boyd, M. L., and Floyd, Earl. The value of pyelo-ureterograms in obscure kidney lesions. *Jour. M. Assn. of Georgia*, Nov., 1923, xii, 429–440.

This article calls attention to the necessity of proper technic to get the result, calling attention to Case V of those he reports in which the patient was cystoscoped, given functional tests, had several pyelograms, but without correct diagnosis until a pyelogram was taken with the patient standing and 10 c.c. of sodium bromide solution injected through the ureteral cathete which showed the kidney lying with the lower pole overlapping the ilium and its pelvis at about the level of the fourth lumbar vertebra.

The symptoms which may arise from kidney lesions are so diverse and so closely resemble those of lesions of other organs that often all of the diagnostic methods fail until a pyeloreterogram has been made, particularly in right sided nephroptosis in stout people. Sometimes the pain from the abnormally placed kidneys is felt in front near the region of the appendix, and as there is often associated gastrointestinal disturbance it is not out of place to suspect appendicitis. A pyelo-ureterogram is indicated in almost every kidney case that is to be operated on. The first exposure for a pyelo-uretergram is taken with patient lying down, employing a lead infiltrated catheter, with the tip in the pelvis of the kidney not in the ureter or a calyx. Inject a few c.c. less of the solution used (sodium iodide or bromide) than the measured kidney capacity. Take the second exposure with patient in semi-sitting or standing position; the third after the catheter has been withdrawn to the lower ureter. Between these exposures the catheter is allowed to drain out the injected fluid, and reinjections are made before each exposure. There follow the details of 7 cases.

Chapman T. L. The value of basal metabolism in a general surgical practice. *Minn. Med.*, Feb. 1924, vii, 89–90.

The studies of Boothby and others appear to justify the conclusion that 95 per cent of all abnormally increased metabolic rates are due to hyperthyroidism either of exophthaimic goiter or adenoma with hyperthyroidism, providing febrile states are eliminated, and proper conditions essential to physical and

mental repose and the various necessary inactivities and inhibitions are complied with.

Lowered rates are found in the largest percentages in myxedema of varying grades of development and inanition from restricted food intake.

Of first importance in surgical practice are the basal rates in the diagnostic estimates of goiters, giving positive or negative information that may be of prime importance.

A large number of colloid goiter patients with coincident nervous circulatory peculiarities, can be catalogued on a more certain diagnostic basis than before, by means of basal rate readings.

CRILE, G. W. The cancer problem. *J. Am. Dent. Assn.*, Jan. 1924; 3–5.

Crile quotes tables of 168 cases of buccal cancer, 13 per cent of which were due to defective teeth. These included 45 cases of cancer of jaw and mouth, 30 per cent of which were due to dental conditions. It is obvious that chronic irritation of tongue and buccal cavity by teeth or ill fitting dental work cannot fail to be a distinct menace. He says, "I have never seen a cancer of the mouth in a perfectly sanitary mouth with normal teeth." Cancer is always preceded by a remediable precancerous condition, which in the mouth can often be seen and corrected.

These cancers do not metastasize so readily to distant parts as do the cancers of other regions of the body. The collar of lymphatics in the neck form an almost impassable barrier through which cancer rarely penetrates.

Cancer of each part of the head seems to follow a law of its own, so far as its primary extension is concerned. Cancers of the skin, mucuous membrane, of the cheeks, and of the edge of the jaw do not usually metastasize; cancer of the lip almost uniformly metastasizes to the lymphatic glands under the jaw; cancers of the floor of the mouth into the glands of the same side, etc. However, the metastasis may occur at any site high or low on the right or left side. Early cancer of the mucous membrane of the gums or cheeks does not demand excision of the glands, while cancer of the lip, however early, demands complete excision of all lymph nodes draining the involved tissue. Cancer of the tongue or lips calls for complete removal of the glands of the neck on both sides. Cancer of the jaws demands a less radical procedure.

"As for the care of the precancerous lesion, radium and roentgen ray play an important part. The proper application of radium to an obstinate ulcer of the lip, gum or cheek, is the most efficient prophylactic measure. Once the cancer has developed, surgical operation alone remains, but when this is done the best results come when a single treatment of deep accurately measured roentgen ray or radium dosage is added. In the precancerous stage the cooperation of the dentist surgeon and roentgenologist is important to the patient."

DELBET, PAUL, and THOMAS, JOSEPH. The actual situation in cancer therapeutics. *Les Néoplasmes*, May and June, 1923, ii, 119–124.

This article proposes to give fairly both sides in the various methods used in the cancer fight. All available cancer was treated in the first place by radium. If the neoplasm is small a complete cure results without the risks of operation, if large, subsequent operation is made easier and the risk of dissemination during operation made less.

But radium should not be applied in a haphazard way. It should be buried within the mass, with precision at the selected place, and when so done, is truly a surgical operation. The surgeon makes the diagnosis, but the radium therapeutist applies the radium, selecting the positions and dose. The application of radium in the larger neoplasms, should be followed by the work of the surgeon.

EISEN, PAUL. Duodenal regurgitation. *Jour. of Radiol.*, Nov., 1923, iv, 388–390.

This is a study of regurgitation from the duodenum into the stomach. In a series of 109 cases from Aug., 1921 to Oct., 1922, reverse peristalsis was met with nine times, 4.7 per cent. The clinical significance is not yet known. In one case the stomach was nearly empty, at the end of three hours, and nearly full again at the end of six. It must be considered as a contributing factor in gastric retention.

ESAU. Median nasal cleft associated with congenital dermoid. *Fortschr. a. d. Geb. d. Roentgenstrahlen.* 1923, xxxi, 262.

A girl, aged seventeen, was presented for examination on account of a flattening of the upper part of the nasal ridge which did not form an acute angle, but a surface of up to 2.5 cm. The roentgenogram showed the nasal bones to be moved apart in the upper portion, below in the median line. A light space was seen in the interspace which reached far under the glabella. This light space was the picture of a cyst which, when operated, proved to be, as had been surmised, dermoid. A mass of fair hair was removed from between the gaping nasal bones, and the walls of the cyst were removed for some distance under the glabella and the vomer.

The region of the nasal and orbital bones has often been reported as the site of dermoid cysts. This condition in the girl was congenital, and had been noticed as a protrusion soon after birth.

FLEISCHER, F. Does the patella bipartita belong to the juvenile osteochondric diseases? *Fortschr. a. d. Geb. d. Roentgenstrahlen*, 1923, xxxi, 209.

A soldier, aged twenty-eight, showed roentgenological signs of Schlatter's disease. Bony particles were contained in the patellar tendon, and one of them evidently had been fractured recently. In the left knee a patella bipartita existed. Both conditions are rare. The anomaly and the disease had evidently existed for years, but the patient had not much discomfort from either. A certain cartilage and bone weakness had probably existed and a deformation and pathological condition had developed in consequence of some functional strain. The damage is liable to be wrought during the time of growth, resulting on one side in a division of the patella, in the other in a faulty distribution of bony particles.

FOX, HAROLD. Concurrent hydropericardium and pneumothorax. *J. Am. M. Ass.*, Feb. 9, 1924, lxxxii, 467.

This combination of pathological conditions is rare. The case reported was a married man, aged thirty-six, who first noticed trouble in chest when nineteen. On July 25, 1922, first noticed heart beat on right side. Maximum intensity 1½ inches to right of sternal margin. On Oct. 15, there was a sudden attack of pain at the back of left shoulder. Temperature 102°. This lasted about a week, heart appeared to patient to be farther to the right of sternum. Jan. 3, 1923, he was seized with a sudden short pain in the posterior to the left shoulder pain going down to costal margin on left side of thorax; breathing sounds on left side diminished, increased in intensity on right side; heart sounds difficult to hear. Point of maximum intensity 2 in. to right of sternal bone in fifth interspace. Pulsation could be felt all over right lower thorax and upper abdomen on the right side. The percussion now ranged from dull to flat. The line between liver and pericardial dullness could not be made out. The liver dullness extended four finger breadths below the costal margin. A peculiar splashing sound could be heard at times over the area of cardiac dullness. The patient appeared to be in a state of shock. The roentgen ray revealed a well defined shadow above and to the left of the cardiac shadow, which on succession, showed a well marked fluid wave, and which, on changing position showed a changing fluid level. There was a shadow indicating collapse of nearly all of the left lung. A diagnosis of pericarditis with effusion, with pneumothorax and collapse of the major part of the left lung was made. The case was operated, the pericardium drained, the left chest aspirated, removing 500 c.c. of air. Respiration with pressure apparatus restored the lung function, and the heart beat returned to left side, the patient making a recovery.

FLEISCHER, F. Multiple epiphyseal disturbances in the hands. A so-far unknown localization of juvenile osteochondropathy. *Fortschr. a. d. Geb. d. Roentgenstrahlen*, 1923, xxxi, 206.

A girl, aged fourteen, noticed swelling in the proximal portions of the interphalangeal joints of all fingers of both hands. The condition had been diagnosed as syphilis of the bones by another physician. The Wassermann reaction was however negative and the roentgenogram contradicted this opinion. The clinical course and the age of the patient did not point to osteochondritis, dactylitis, osteoperiostitis, bone gumma or syphilitic arthritis. The Pirquet reaction was negative. The roentgenogram showed no periosteal reaction, the bony structure was clearly delineated and differentiated from the articular cleft. No circumscribed light spots or general calcium depletion were seen. The course was slow. For these reasons caries, spina ventosa and articular fungus were barred. Osteomyelitis was very improbable on account of the epiphyseal involvement and the symmetrical location. Late rickets attacks the entire bony system, and in juvenile cases is restricted to the lower extremities and the trunk. Moeller-Barlow's disease, arthritis, trauma, neoplasm, and syphilis did not seem to be the correct etiology. It was a condition of the growing stage of life, a juvenile osteochondroplastic disease.

GRAGERT, O. A simple procedure for the production of artificial pneumoperitoneum, *Ztbl. f. Gyneck.*, 1923, xlvii, 144.

An instrument was devised by the author, for insufflating air into the peritoneal cavity before putting the patient in front of the screen. It consists of a blunt drain with an olive tip, which is used as an insufflation needle, much as Hoehne has used in provocative camphor oil treatment before operations. It is like a common lumbar puncture tube. After removing the olive a sterile rubber tube is attached which carries a three-way valve. It leads into a sterile Jeannet syringe of 200 c.c. volume. By opening or closing the valve, air can be

aspirated and slowly insufflated by the syringe which then serves as a pump. The air is sterilized by a cotton plug in a glass drain which is inserted near the point where the air enters the valve.

The intestines are well evacuated and the patient put in the dorsal or high pelvic position, is given 0.005 gm. morphine half an hour before the insufflation is made. The umbilical region is disinfected and the skin scarified with a sharp scalpel, and the drain with the olive passed in. The olive tip is then removed and the rubber tube leading to the three-way valve is drawn over the end of the drain. Then the air is aspirated by means of the syringe, the valve turned and the air slowly insufflated; then the valve is turned back. If one is in doubt whether the needle is in the abdominal cavity the stethoscope will give information.

Generally 800 c.c. of air will be enough. After insufflation the drain is removed and the slight wound treated aseptically. The air will be absorbed spontaneously within four days. If one wishes to remove it, one can make another puncture. It is advisable to keep the patient prone for some time after the examination.

GLASSER, OTTO, Newer investigations of gamma-ray dosage of radium. *J. Radiol.*, Nov., 1923, iv, 386–388.

The laws of distance and absorption, do not apply, because of the scattered rays.

Isodoses are the dose curves resulting from studies made with a standard radium tube, and an ionization chamber, the required dose being calculated on this isodose curve. These isodosic curves vary with the form and material used in the containers and filters for radium.

HERRNHEISER, G. Costomediastinal indurations. *Fortschr. a. d. Geb. d. Roentgenstrahlen*, 1923, xxxi, 165.

Costomediastinal indurations are often put under the head of pleuritis mediastinalis. It is, however, not an inflammatory process. Generally it is not strictly localized between the pleura and the mediastinum. The condition in the roentgenogram will cause a homogeneous shadow which is closely related to the central shadow. Where the rays extend in the sagittal direction, the shadow of the exudate is paramediastinal, intracardiac or para-vertebral. According to Savy, there is an anterior and a posterior (retrocardiac) pleuritis mediastinalis. It is generally found in the lower section of the thorax, and in some instances in the upper part, either on the right or left side, and only exceptionally is bilateral. The shape of the roentgen shadow is influenced by location and size of the exudate. Small exudates in the anterior pericardial pleura do not reach beyond the cardiac border shadow, and therefore may escape notice (Lorey). An anterior mediastinal pleuritis of medium extent forms a shadow parallel to the cardiac shadow, so to speak, doubling the latter. When the exudate increases, a triangle forms with its base downward, filling the cardiodiaphragmatic angle. The presence of air or gas (pyopneumothorax mediastinalis) blunts the apex of the triangle, even converting it into a horizontal line. When the exudate forms above and in front it will often cause a band-shaped shadow. Posterior mediastinal pleuritis will sometimes cause a para-vertebral shadow, or may be seen as a triangle which is distinguishable through the cardiac shadow. Groedel saw an almost sac-shaped contra-lateral horizontal shadow in a high retro-cardial exudate of the right side.

The lateral border of the shadow of the exudate is straight, convex, or concave, and mostly smooth. In one of Groedel's cases the shadow was notched.

Differentiation between costomediastinal and mediastinal indurations must be made on the basis of the anatomical location of the substratum of the roentgenological demonstrable shadow. The mediastinal shadows are seen in the mediastinal cleft proper, the costomediastinal at the costomediastinal sinus. Costomediastinal indurations are not uncommon. Generally they are the consequence of serous or fibrinous pleuritis of the sinus, mostly of tuberculous, more rarely of metapneumonic nature. The clinical signs of the costomediastinal indurations are not characteristic. They may cause more or less severe discomfort. In other instances they remain without symptoms.

Frontal roentgenograms will not show up the costomediastinal indurations. Basal indurations are hard to differentiate in the left anterior sinus from mediastinal adhesions on the cardiac surface. Mostly costomediastinal adhesions are combined with true mediastinal adhesions. This combination generally escapes the roentgenological plate.

JAUBERT, M. A. de Beaujeu. Researches on the luminescence by roentgen rays. *Le Jour. de Phys. et le Radium*, Aug., 1923, S. vi, v. iv, 257–267.

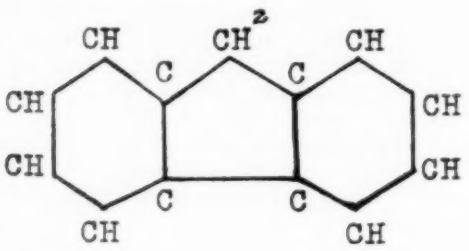
A certain number of solid dissolutions of rare earths were prepared after the method of Tubain and Brüningshaus, from which were obtained with roentgen-ray spectra luminescence composed of rays and bands, comparable in every way with cathode spectra. They differed in the number of rays with cathode

spectra. They differed in the number of rays and bands which they revealed.

The energy of the roentgen ray was more feeble than that of the cathode ray. The material employed, was not as pure as that of Tubain and Brüningshaus.

Most beautiful fluorescence was obtained with double salts of uranium dioxide.

The platino-cyanides of ammonia, rubidium, lithium, barium, potassium, thorium and magnesium, gave a continuous spectrum. A series of compound phosphorescent sulphides, prepared by the method of Lenard and Klatt, gave continuous spectra.



The literature of roentgen-luminescence for organic bodies is very meager. The luminescence of some organic bodies has been known since the discovery of the ray, but there has been no systematic research. At first, it was proposed to make a fluorescent screen with "Pentadecylparatolycétone."

But this substance which lights up with the cathode ray, does not light at all with the roentgen ray, as Precht affirmed in his two reports.

Systematic examination was made of as large a number as possible of organic solids, classifying them by chemical formulae. Here, as in mineral substances, the employment of a bulb of Lindemann glass has its importance, because a large number of organic preparations which shine very little with the ordinary bulb, become very luminous with this bulb.

Only solid bodies were examined; the spectra were taken with the direct vision instrument of Hilger. The ultraviolet spectrum was not examined. It is necessary to pass from 5 to 12 ma. into the bulb to get sufficient intensity of ray.

A study was made of several of the condensed ring carbides and some of their derivatives, fluorine anthracine, etc. All of these carbides are remarkable for the fluorescence which is easily caused by the roentgen ray. The least brilliant is naphthaline

Chemically pure fluoréne shines with an intense violet brilliancy under the influence of roentgen ray. The emitted light is a blue violet and presents a characteristic spectrum. Réléne, one of the higher homologues of anthracene, when purified, lights up with an intense blue green; when chemically pure, it lights up a clean screen with an intense blue violet, more or less similar to that of anthracene, which itself, gives an intense blue violet.

Conclusions: 1. There are a large number of solid organic substances which can be rendered fluorescent by the roentgen ray.

2. The aromatic substances are the most fluorescent and it is concluded that the benzene ring is the principal fluorophore.

3. The degree of purity influences greatly the luminescence; the purer the material the more brilliant the light.

LANDAU, W. Neurogenous disturbances of deglutition accompanied by entry of the contrast medium into the respiratory tract shown in the roentgenogram. *Fortschr. a. d. Geb. d. Roentgenstrahlen*, 1923, xxxi, 291.

When a man, aged 44, was examined for intestinal disturbances the contrast medium was seen to form a peg-shaped protrusion, posteriorly on the level of the bifurcation of the esophagus. It disappeared quickly, and suggested a diverticulum. Soon after, however, branched bands were seen in the retrocardial field, which, upon posterior examination, were recognized as bronchial branches in the lower lobe of the lung. Trachea and larynx were likewise well outlined. The patient did not cough till several minutes later, though he had a history of pneumonia and pleuritis and was suffering from indurating pulmonary tuberculosis, and the heart was displaced by pleural adhesions. He later said that he avoided fluids on account of their regurgitation through the nose. Evidently the coordination of the deglutition process was defective. A slight weakness of the right lower part of the facial nerve existed. The gagging reflex was diminished. An old focus of chorioretinitis was found in the right eye, and the sympathetic showed a paresis. The diagnosis of congenital syphilis was made on the basis of ocular findings. The defective deglutition was probably due to a vagus paresis of luetic origin.